



AERONAUTICAL ENGINEERING

A SPECIAL BIBLIOGRAPHY

WITH INDEXES

Supplement 58

JUNE 1975

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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 58

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in May 1975 in:

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*



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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued.

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 484 reports, journal articles, and other documents originally announced in May 1975 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries* in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

Three indexes—subject, personal author, and contract number—are included.

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TABLE OF CONTENTS

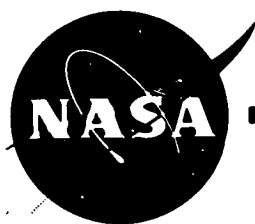
	Page
IAA Entries	179
STAR Entries	221
Subject Index	A-1
Personal Author Index	B-1
Contract Number Index	C-1

TYPICAL CITATION AND ABSTRACT FROM STAR

NASA SPONSORED DOCUMENT		AVAILABLE ON MICROFICHE
ACCESSION NUMBER	N75-10005*# Lockheed-Georgia Co., Marietta.	CORPORATE SOURCE
TITLE	GROUND EFFECT FOR V/STOL AIRCRAFT CONFIGURATIONS AND ITS SIMULATION IN THE WIND TUNNEL. PART 3: THE TANGENTIALLY BLOWN GROUND AS AN ALTERNATIVE TO A MOVING GROUND: APPLICATION TO THE NASA-AMES 40 BY 80-FOOT WIND TUNNEL	PUBLICATION DATE
AUTHORS	J. E. Hackett, E. B. Praytor, and E. O. Caldwell [1973] 59 p refs	AVAILABILITY SOURCE
CONTRACT OR GRANT	(Contract NAS2-6690)	COSATI CODE
REPORT NUMBER	(NASA-CR-114497) Avail: NTIS HC \$4.25 CSCL 01B	
	<p>A set of conceptual drawings showing the application of slot-blowing boundary layer control to the 40- by 80-foot wind tunnel is presented. In small scale pilot experiments unswept slots were used, fed by a below-floor plenum. The model was sting mounted and its wing was unswept. However, design for the Ames tunnel was heavily constrained, both by under floor balance mechanisms and by a large turntable. An over floor supply system was therefore designed. A description of appropriate procedures for using the floor tangential blowing system is given. Though some of the operating graphs are specific to the design for the Ames tunnel, both non-dimensional plots and the approach generally are widely applicable.</p> <p>Author</p>	

TYPICAL CITATION AND ABSTRACT FROM IAA

NASA SPONSORED DOCUMENT		AVAILABLE ON MICROFICHE
ACCESSION NUMBER	A75-10336*#	TITLE
AUTHORS	Sealing technology for aircraft gas turbine engines. L. P. Ludwig and R. L. Johnson (NASA, Lewis Research Center, Cleveland, Ohio). <i>American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 10th, San Diego, Calif., Oct. 21-23, 1974, AIAA Paper 74-1188.</i> 12 p. 23 refs.	AUTHORS' AFFILIATION
	Experimental evaluation under simulated engine conditions revealed that conventional mainshaft seals have disadvantages of high gas leakage rates and wear. An advanced seal concept, the self-acting face seal, has a much lower gas leakage rate and greater pressure and speed capability. In endurance tests (150 hr) to 43,200 rpm the self-acting seal wear was not measurable, indicating that noncontact sealing operation was maintained even at this high rotative speed. A review of published data revealed that the leakage through gas path seals has a significant effect on thrust specific fuel consumption, stall margin, and engine maintenance. Reducing leakages by reducing seal clearances results in rubbing contact, and then the seal thermal response and wear determines the final seal clearances.	TITLE OF PERIODICAL
	(Author)	PUBLICATION DATE



AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 58)

JUNE 1975

IAA ENTRIES

A75-22791 * Propagation of sound in elliptic ducts. M. V. Lowson and S. Baskaran (Loughborough University of Technology, Loughborough, Leics., England). *Journal of Sound and Vibration*, vol. 38, Jan. 22, 1975, p. 185-194. 14 refs. Research supported by the National Gas Turbine Establishment of England and NASA.

The paper studies the propagation of sound in an elliptic duct, which is of considerable interest in the field of jet-engine noise reduction. The cutoff frequencies of the higher-order circumferential modes in an elliptic duct are calculated for various duct eccentricities. The results indicate that, if equal inlet area is retained, even major deformations of the inlet shape will have virtually no influence on the cutoff conditions of the radiated sound. A.T.S.

A75-22795 Finite element flutter analysis of multi-web wing structures. S. S. Rao (Indian Institute of Technology, Kanpur, India). *Journal of Sound and Vibration*, vol. 38, Jan. 22, 1975, p. 233-244. 13 refs.

The flutter analysis of multi-web aircraft wing structures is considered by using finite element idealization. The constant stress triangular membrane elements, the rectangular shear panels and the pin-jointed bar elements are used to idealize the wing structure. The order of the aerodynamic, mass and stiffness matrices of the assembled structure is reduced by introducing the first few natural modes of the structure as generalized coordinates. The approach is quite general and is applicable to any multiple-web wing structure with arbitrary configuration, which might have cutouts and other structural discontinuities. Three example wing structures are considered to illustrate the effectiveness of the approach and the present finite element results are found to be in good agreement with those given by other conventional methods. (Author)

A75-22796 The response of a vibrating structure as a function of structural parameters. G. T. S. Done and A. D. Hughes (Edinburgh, University, Edinburgh, Scotland). *Journal of Sound and Vibration*, vol. 38, Jan. 22, 1975, p. 255-266. 6 refs.

The response of a structure excited by an external oscillatory force is examined for variations in certain structural parameters of the system. This is done with a view to manipulating the structure in order to achieve a desired response. The variation of the response with one structural parameter is seen to be simple, and the effect of changing in addition the forcing frequency is illustrated. When two structural parameters are considered, it is seen that a desired response may or may not be attainable, as defined by a 'feasible response region'. The application to practical cases is discussed briefly. (Author)

A75-22798 Fundamental frequency of a square panel with multiple point supports on edges. G. V. Rao (Indian Space Research Organization, Space Science and Technology Centre, Trivandrum, India). *Journal of Sound and Vibration*, vol. 38, Jan. 22, 1975, p. 271.

A75-22868 Experimental determination of the separation point of flow around a circular cylinder. D. W. Ballengee and C. F. Chen (Rutgers University, New Brunswick, N.J.). In: *Flow: Its measurement and control in science and industry*. Volume 1. Part 1. Pittsburgh, Pa., Instrument Society of America, 1974, p. 419-427. 9 refs. Contract No. F44620-68-C-0018.

The separation point on a circular cylinder in laminar flow has been determined for a Reynolds number range of 10,000 to 45,000. The dual-element hot-film probe developed by Caldwell was used for the determination of the separation point. The probe consists of two heated elements of small dimensions, one mounted directly behind the other in the flow field. The downstream film is in the thermal wake of the upstream film. If both of these are operated as constant-temperature hot-film probes, the voltage required for the downstream probe will be less than that needed for the upstream probe. The situation is reversed when the flow direction is reversed. At the separation point, the voltage difference will be zero. It is found that at the higher end of the Reynolds number range tested, our data agree well with the previous results, whereas at the lower end of the Reynolds number range, our results show larger angles of separation than the existing data. (Author)

A75-22880 Nonintrusive ultrasonic measurement of flow velocity and mass flow rate. L. C. Lynnworth, N. E. Pedersen, E. P. Papadakis, and J. H. Bradshaw (Panametrics, Inc., Waltham, Mass.). In: *Flow: Its measurement and control in science and industry*. Volume 1. Part 2. Pittsburgh, Pa., Instrument Society of America, 1974, p. 917-924. 25 refs.

A75-22934 The scattering of sound by a vortex sheet. U. S. Jones (Dundee, University, Dundee, Scotland). *Institute of Mathematics and Its Applications, Journal*, vol. 15, Feb. 1975, p. 33-57. 9 refs.

The effect of radiation from an acoustic point source on the vortex sheet separating two fluids in relative motion is analyzed. Supersonic flow speeds are allowed for, and sources that are either harmonically varying or pulsed in time are considered. It is found that waves due to Helmholtz instability are always present and dominate other disturbances at any Mach number. This contrasts strongly with excitation by a line source, where instability disappears at Mach numbers below two times the square root of 2. The flow pattern exhibits a bow wave that moves ahead of other disturbances; at Mach numbers greater than 2, a second bow wave appears between the first bow wave and the other waves. Also, there is a neutral stability wave which is singular at its front. At Mach numbers greater than two times the square root of 2, further waves are generated which display the same kind of singularity. V.P.

A75-22938 Altitude evaluation of a variable cycle turbofan engine. D. W. Stephenson, W. R. Davenport (AirResearch Manufacturing Company of Arizona, Phoenix, Ariz.), and R. F. Topping (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 1-3, 1974, Paper 740806*. 10 p. 5 refs. Members, \$1.75; nonmembers, \$2.75.

This paper presents the results of an altitude test evaluation of a variable-cycle turbofan engine. The test engine was a medium-bypass, two-spool turbofan engine modified to incorporate variable inlet guide vanes and first-stage stators in the low-pressure compressor, variable first-stage stator vanes in the low-pressure turbine, and variable area fan and primary exhaust nozzles. The results of the testing indicated that these variable-geometry components offer potential improvements to the following problem areas in multi-mission aircraft at off-design conditions: inlet spillage drag and exhaust-system boat-tail drag, compressor surge-margin control, airframe bleed-air extraction effects on engine performance, and performance limited by engine operating limits. (Author)

A75-22939 AFTI Ti-1 program. R. L. Haas, W. M. O'Connor, and D. E. Fraga (USAF, Systems Command, Andrews AFB, Washington, D.C.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 1-3, 1974, Paper 740860*. 14 p. Members, \$1.75; nonmembers, \$2.75.

The advanced fighter technology integration (AFTI) program is a concept for accelerating the transition of high payoff technologies through the development stage into systems application. Attention is given to the four phases of the first program to incorporate the AFTI approach. The development of advanced controls is considered along with a high-acceleration cockpit, advanced composites, drag modulation, a technology options study, aspects of design efficiency, system effectiveness, total system cost, alternate capability enhancement, and configuration selection. G.R.

A75-22940 F-4/CCV-flight tests of advanced technology. D. H. Bennett (McDonnell Aircraft Co., St. Louis, Mo.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 1-3, 1974, Paper 740861*. 9 p. Members, \$1.75; nonmembers, \$2.75.

Previous studies indicated the F-4 fly-by-wire (surfaces controlled by electrical signals rather than by mechanical inputs) aircraft to be a good test bed for flight tests of advanced concepts. In particular, the advanced technology control configured vehicle (design for control, rather than stability, in initial design phase) concepts of a short-coupled horizontal canard (control surface forward of the wing) and relaxed static longitudinal stability were shown to have large performance benefits for maneuvering flight conditions in the combat arena. The short-coupled canard has slat-like favorable interference effects on the wing lift and drag characteristics, regardless of whether leading edge slats are or are not installed on the wing. Development of the company-sponsored precision aircraft control technology aircraft to flight status was not without challenges, but these were satisfactorily met. Flight tests have verified the predicted performance benefits, while providing additional reliability/maintainability data on fly-by-wire control systems. (Author)

A75-22944 Advanced composite design concepts for the AMST. W. D. Nelson (Douglas Aircraft Co., Long Beach, Calif.) and D. A. Roselius (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 1-3, 1974, Paper 740870*. 13 p. 8 refs. Members, \$1.75; nonmembers, \$2.75.

In this study, graphite-epoxy composite materials are used in conceptual design of major structural portions of an advanced medium STOL transport (AMST) aircraft. Low-cost design concepts combined with innovative manufacturing techniques contribute to a

unit cost reduction of \$760,000 and a life-cycle cost saving of \$474 million for a resized composite aircraft using pitch-based fiber, and maintaining the same performance as the larger baseline metal aircraft. When the composite design weight savings were converted to performance improvements, rather than to resizing, the vehicle could carry 20.4-percent more payload weight, fly the baseline payload 46.3 percent farther, or take off from a 6-percent shorter runway.

(Author)

A75-22948 F-15 secondary power systems. H. S. Ostroff (McDonnell Aircraft Co., St. Louis, Mo.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 1-3, 1974, Paper 740885*. 6 p. Members, \$1.75; nonmembers, \$2.75.

A description is given of innovations in fighter aircraft secondary power systems, taking into account the reasons which led to the use of these systems in the F-15. The F-15 accessory drive system is discussed along with accessory drive improvements for future fighters, questions of secondary power distribution protection, and aspects of secondary power integrity. Hydraulic leakage problems can be significantly reduced by the employment of the newly developed swaged hydraulic fitting. Operating experience with the F-15 has borne out the predicted maintenance-free nature of the permanent joints. G.R.

A75-23009 # Investigation of the structure and properties of niobium in vacuum and in high-velocity air streams (Issledovanie struktury i svoystv niobiia v vakuumе i v skorostnom vozdušnom potoke). I. N. Bogachev, V. P. Lesnikov, and V. G. Sorokin. In: Temperature microscopy of metals and alloys. Moscow, Izdatel'stvo Nauka, 1974, p. 99-103. In Russian.

A75-23043 # Connection between the flight plan and the repair hangar control plan and its meaning for the quality of the transport process (Bedeutung des Zusammenhanges zwischen Flugplan und Kontrollplan der Werft für die Qualität des Transportprozesses). P. Bork (Gesellschaft für internationalen Flugverkehr mbH, Berlin, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 10, no. 6, 1974, p. 309-319. In German.

Measures are proposed to improve the quality of transportation methods. The advantages and disadvantages of dividing maintenance work up into blocks are enumerated. It is emphasized that constant variation in the number of aircraft serviced makes the work difficult to coordinate. Two aspects of planning must be stressed if the airplanes are to be completed on schedule: (1) the inspection plan of the repair hangar should have a minimal relationship to the uniformity of the workload; (2) the flight plan should be as compact as possible, i.e. turnover of aircraft should be accomplished with a minimal number of aircraft being repaired at a time. S.J.M.

A75-23044 # Maintenance overhauls performed according to an overhaul schedule (Durchführung von Wartungsarbeiten nach Ablaufplan). J. Bolte (Gesellschaft für internationalen Flugverkehr mbH, Berlin, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 10, no. 6, 1974, p. 320-324. In German.

Advantages and disadvantages of using overhaul schedules to program aircraft repair are discussed. The design and function of these schedules with respect to organizational and technological factors is explained, and the consideration of disturbance variables in design and function is described. An example of an overhaul schedule system is given, consisting of six eight-hour shifts. An analysis of empirical knowledge about overhaul schedules is provided. S.J.M.

A75-23045 # Methods of production planning in aircraft maintenance (Methoden der Durchlaufplanung in der Flugzeug-instandhaltung). G. Rieger (Gesellschaft für internationalen Flugverkehr mbH, Berlin, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 10, no. 6, 1974, p. 325-329, 349. In German.

Presently employed and proposed planning methods for the performance of aircraft servicing operations are discussed. The primary goal of this planning will be to keep as many aircraft as possible ready for take-off, and to maximize the conditions necessary to do this with the labor available. Two provisions must be satisfied in order for the planning to succeed: a plan for aircraft preparation must be available, and technical resources and speed in technical processes for all test procedures and aircraft types must exist. S.J.M.

A75-23046 # Observations on the construction and use of airplane hangars (Erfahrungen beim Bau und Einsatz von Flugzeugdocks). H. Böhm (Gesellschaft für internationalen Flugverkehr mbH, Berlin, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 10, no. 6, 1974, p. 330-334. In German.

Various means of economizing hangar construction while preserving or improving weather protection and service access are presented. Placing a hole in the hangar for the nose to protrude through and cutting a notch in the hangar entrance wall to accommodate the tail are two of these means. The possibility of modifying existent facilities to fit larger aircraft is discussed. S.J.M.

A75-23047 # The defect recording system and defect statistics for aircraft technology used by the CSA (System der Registrierung und Statistik von Defekten der Flugzeugtechnik bei der CSA). Z. Stehlik. *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 10, no. 6, 1974, p. 337-344. In German.

A system for entering information about aircraft defects in an orderly, accessible manner is discussed. The present state of aircraft technology, the nature of technical overhauls, the goal of the registering system, the demands made on this system, current progress in the field of defect data entry, and an overall perspective of the endeavor presenting some of the problems encountered and foreseen are given. Sample data entry forms are diagrammed. S.J.M.

A75-23048 # Applications of electronic data processing in aircraft maintenance (Anwendung der elektronischen Datenverarbeitung in der Flugzeuginstandhaltung). W. Roepke (Gesellschaft für internationalen Flugverkehr mbH, Berlin, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 10, no. 6, 1974, p. 345-349. 5 refs. In German.

Several concepts involved in complex applications of electronic data processing in the planning and control of servicing procedures are explained. The paper lays the groundwork for a mutual exchange of ideas and questions among civil airlines. The importance of aircraft repair within an airline company, global processing models and results obtained with them, the present state-of-the-art, and the need for conceptual preparation for a processing project are discussed. S.J.M.

A75-23049 # Methods of inspecting and preventing work defects during maintenance (Methoden zur Überwachung und Gewährleistung der fehlerfreien Arbeitsdurchführung im Instandhaltungsprozess). R. Weinhold (Gesellschaft für internationalen Flugverkehr mbH, Berlin, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 10, no. 6, 1974, p. 350-356. In German.

Various causes of mistakes, damage, disturbances, and accidents, and remedies to these causes available at the present time are discussed. Among the causes described is scarcity of information. A diagram explaining the consequences of this lack is presented. Defects in workmanship resulting from information can be due to false information itself or to the misuse of correct information. The definition, investigation, and evaluation of events such as accidents or disturbances is treated in detail. Education about faulty working techniques is emphasized. A brief overview of future projects in the field is provided. S.J.M.

A75-23099 # Pressure increase in blade channels of axial-flow compressors at low gas pressures (Druckerhöhung in Schaukelkanälen von Axialverdichtern bei niedrigen Gasdichten). C. H. Chun. *Rheinisch-Westfälische Technische Hochschule, Aerodynamisches Institut, Abhandlungen*, no. 21, 1974, p. 30-35. 7 refs. In German.

The investigation was conducted in connection with studies concerning the possibility to use the axial-flow compressor as a vacuum pump in technological applications. The work performed in the case of a blade of an axial-flow compressor is considered, taking into account the energy distribution function for the transitional region. A three-zone flow model is used, giving attention to components in a frictionless zone and a zone with friction effects. Theoretical results agree qualitatively with measurements conducted by Becker (1958) and Hablani (1900). G.R.

A75-23100 # The effect of initial values on wing form and the limiting curve of the wave drag coefficients of optimized symmetrical-thick delta wings in supersonic flow (Einfluss der Anfangswerte auf Flügelform und Grenzkurve der Wellenwiderstandsbeiwerte optimierter symmetrisch-dicker Deltaflügel in Überschallströmung). A. Nastase. *Rheinisch-Westfälische Technische Hochschule, Aerodynamisches Institut, Abhandlungen*, no. 21, 1974, p. 53-57. 17 refs. In German.

It is assumed in the investigation that the flow is isentropic, steady, and frictionless. A vertical perturbing velocity is produced or approximated with the aid of a superposition of homogeneous polynomials. The approach makes it possible to apply a theory developed by Germain (1949). This theory provides an exact solution of the complete potential equation. In the determination of the optimized wing form use is made of a graphical-analytical method described by Nastase (1973, 1974). The method is also utilized in a study involving the systematic variation of the thickness ratio, the cruising Mach number, and the similarity parameters. G.R.

A75-23125 Airport noise abatement - How effective can it be. J. E. Wesler. *Sound and Vibration*, vol. 9, Feb. 1975, p. 16-21. 5 refs.

The recent DOT 23-Airport Study provided a detailed cost-effectiveness comparison of two potential aircraft modification (retrofit) programs in reducing the noise exposure around U.S. airports. Based on those results, a simplified model of a 'representative airport' was derived and used to compare additional airport noise abatement alternatives, including both operational procedures as well as aircraft modifications. Each of the assumed alternatives can be effective in reducing airport noise impact, but all of them together will not remove the problem entirely. (Author)

A75-23152 On stress in service condition and estimated fatigue life of blades in axial flow compressor. H. Nakamura, R. Umakoshi, T. Horikawa, and S. Okazaki (Kawasaki Heavy Industry Co., Ltd., Technical Research Laboratory, Akashi, Japan). *Japan Society of Materials Science, Journal*, vol. 24, Jan. 1975, p. 9-14. 14 refs. In Japanese, with abstract in English.

The present work gives the results of tests conducted to evaluate the fatigue strength of the blades of an axial flow compressor. Tests included strain measurements at operating conditions and fatigue tests on blade materials under several conditions (varying stress amplitude and superimposed stress, in corrosion, etc.). Results of strain measurements of 1st and 14th rotor blade stages are interpreted. It was found that stress-frequency curves depend very much on the cycle counting method and the rate of blade resonance. Fatigue life was found to be best determined by low level stress having many cycles rather than the maximum stress level. P.T.H.

A75-23199 **A solution to the transport of exceptionally large loads - The dirigible (Une solution pour les transports exceptionnels - Le dirigeable).** J. Bouttes and M. Salmon (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (*Annales des Mines*, Oct.-Nov. 1974, p. 75-82.) *ONERA, TP* no. 1454, 1974. 9 p. 7 refs. In French.

Problems posed by the ever-increasing weight of large, indivisible transportation loads are reviewed. The potential benefits and history of the dirigible are summarized, and a policy of development is proposed for it. Some of the other means of large-load transport currently in use are described. S.J.M.

A75-23201 # **Matrix difference equation analysis of vibrating periodic structures.** P. H. Denke, G. R. Eide, and J. Pickard (Douglas Aircraft Co., Long Beach, Calif.). *AIAA Journal*, vol. 13, Feb. 1975, p. 160-166. 10 refs.

The Matrix Difference Equation (MDE) method for sound transmission and forced vibration analysis of damped periodic structures is presented. A periodic structure is defined as a string of identical substructures, such as a segment of aircraft fuselage which has identical bays between circumferential frames. The finite element method is applied to the substructure to provide a mechanical impedance matrix. A matrix difference equation is derived from the impedance matrix, based upon conditions of equilibrium and compatibility at substructure boundaries. The difference equation is reduced in order by eliminating force variables and introducing substructure displacement modes. A solution is found by calculating eigenvalues and eigenvectors of a related characteristic equation. The result is a closed form expression in the longitudinal coordinate. The method is general and applicable to complex structures, because of the finite element basis. Results of an application to aircraft engine duct vibration are included. (Author)

A75-23205 # **Hypersonic viscous slip flow over an insulated flat plate with real gas effects.** A. Sugavanam and M. S. Sastry (Indian Space Research Organization, Space Science and Technology Centre, Trivandrum, India). *AIAA Journal*, vol. 13, Feb. 1975, p. 215-217.

A75-23208 # **Entropy layer on a supersonic plane flat nose at incidence.** R. D. Archer and D. S. Betteridge (New South Wales, University, Kensington, Australia). *AIAA Journal*, vol. 13, Feb. 1975, p. 222-224. 11 refs. Research supported by the Australian Research Grants Committee.

An experiment is described in which evidence was obtained for the location of the maximum entropy streamline behind the detached curved shock on a supersonic two-dimensional flat face. The results support the idea of an entropy layer for such blunt bodies in which the maximum entropy streamline does not wet the body surface. P.T.H.

A75-23209 * # **Calculation of turbulent shear stress in supersonic boundary-layer flows.** C.-C. Sun and M. E. Childs (Washington, University, Seattle, Wash.). *AIAA Journal*, vol. 13, Feb. 1975, p. 224-227. 7 refs. Grant No. NGR-48-002-047.

A75-23222 * # **Measured three-dimensional effects in transonic airfoil testing.** F. X. Hurley (McDonnell Douglas Research Laboratories, St. Louis, Mo.). *AIAA Journal*, vol. 13, Feb. 1975, p. 250-252. Research sponsored by the McDonnell Douglas Independent Research and Development Program and NASA.

An investigation was conducted regarding the issue of deviation from two-dimensionality in flowfield studies of a supercritical airfoil. It was found that significant three-dimensional effects occur in transonic airfoil tests, even for an aspect ratio of four. This is especially true at the supercritical Mach numbers, for which lateral propagation of disturbances is effective. G.R.

A75-23223 # **Separation of turbulent boundary layer on a lifting cylinder.** N. R. Keshavan (Southampton, University, Southampton, England). *AIAA Journal*, vol. 13, Feb. 1975, p. 252, 253. 5 refs. Research supported by the Science Research Council of England.

On a circular cylinder with its axis normal to an airflow lift can be generated by blowing a sheet of air tangentially around the surface from a narrow slot or slots. The air injected through the slot reenergizes the boundary layer and delays its separation. A study is conducted of the flow beyond the slot until the flow separates. A dimensional analysis of the problem is discussed along with some experimental results. G.R.

A75-23224 * # **Miniature probe for transonic flow direction measurements.** F. W. Spaid, F. X. Hurley (McDonnell Douglas Research Laboratories, St. Louis, Mo.), and T. H. Hellman (McDonnell Aircraft Co., St. Louis, Mo.). *AIAA Journal*, vol. 13, Feb. 1975, p. 253-255. Research sponsored by the McDonnell Douglas Independent Research and Development Program and NASA.

A miniature probe is developed for measuring flow direction in one plane as well as stagnation pressure in the boundary layer and near wake of a transonic airfoil. The probe tip geometry and calibration curves are given, along with near wake survey data obtained for a supercritical airfoil. The advantages of the probe are ruggedness, ease of fabrication, ability to measure flow direction at a point, and insensitivity to out-of-plane velocity components. S.D.

A75-23231 # **Stress analysis of aircraft fuselages and pressurized cabins (Raschet na prochnost' fiuzeliazhei i germeticheskikh kabin. samoletov).** V. M. Strigunov. Moscow, Izdatel'stvo Mashinostroenie, 1974. 288 p. 35 refs. In Russian.

The book discusses the methods of stress analysis applicable to aircraft fuselages and pressurized cabins. The problem of determining the external forces acting on an aircraft is explained. General methods for analyzing fuselages, and local stress-analysis methods for structural elements, are given. The effect of cutouts on the torsional and flexural strength of fuselages is analyzed. Special attention is given to situations in which fuselages are subject to total stresses exceeding the strength of the skin. An analysis is made of the overpressure for pressurized cabins containing cutouts. The fatigue strength of a fuselage and its significance in determining aircraft service life is discussed. A.T.S.

A75-23233 # **Static structural test for supersonic aircraft (Staticheskie ispytaniia na prochnost' sverkhzvukovykh samoletov).** A. N. Baranov, L. G. Belozorov, Iu. S. Il'in, and V. F. Kut'inov. Moscow, Izdatel'stvo Mashinostroenie, 1974. 344 p. 76 refs. In Russian.

Recent achievements in the development of static tests for supersonic aircraft are described, with particular reference to the theoretical foundations of methods for reproducing in the laboratory the temperature fields arising due to aerodynamic heating in aircraft structures and the loads experienced in flight. The methods are critically analyzed, and their errors are assessed. The principal questions arising in full-scale ground testing are discussed, and the principal characteristics of test facilities are studied. Particular attention is given to instruments for measuring the various test parameters. Recommendations for using test facilities and for selecting test programs are presented. V.P.

A75-23240 **A leak-free mechanical tube joint.** K. Moebius (Mechanical Seals Corp., Irvine, Calif.). In: *Cryogenic Society of America, National Symposium and Exhibition, 6th, Los Angeles, Calif., October 2-4, 1973, Proceedings.* Flushing, N.Y., Scholium International, Inc., 1974, p. 266-279.

A unique leak-free tube joint with the joint having a greater strength than the parent tubing is described in this paper. It is especially adaptable to cryogenic service and has been qualified for use on cryogenic dewars used on the B-1 bomber. (Author)

A75-23251 # Advanced subsonic transports - A challenge for the 1990's. R. E. Black and J. A. Stern (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 11th, Washington, D.C., Feb. 24-26, 1975, Paper 75-304.* 16 p.

An attempt is made to assess the world subsonic transportation system in 1990s. Trends in world traffic growth, aircraft productivity, acoustics, aerodynamics, propulsion, structures, advanced composite materials, avionics, and advanced subsonic transport are reviewed. Design requirements for subsonic aircraft are seen to be determined by future economic, social, and political conditions, rather than technology. The text is illustrated by numerous graphs and diagrams. S.D.

A75-23295 * Numerical solutions for supersonic corner flow. V. Shankar, D. Anderson (Iowa State University of Science and Technology, Ames, Iowa), and P. Kutler (NASA, Ames Research Center, Computational Fluid Dynamics Branch, Mt. View, Calif.). *Journal of Computational Physics*, vol. 17, Feb. 1975, p. 160-180. 13 refs. NASA-sponsored research.

Analytical solutions for inviscid supersonic corner flows are virtually nonexistent due to the complexity of the interference geometry. In view of this, numerical solutions for swept-compressive and swept-expansive corner flows are obtained. The governing equations are written in strong conservation-law form and are solved iteratively in nonorthogonal conical coordinates by use of a second-order, shock-capturing, finite-difference technique. The computed wave structure and surface pressure distributions are compared with high Reynolds number experimental data and show very good agreement. The results clearly show that supersonic corner flow at reasonably high Reynolds numbers including the effect of sweep is dominated by the inviscid field. (Author)

A75-23298 Supersonic flow of a lightly dust-laden gas past a wedge. H. Miura (Osaka Prefecture, Sakai, Japan). *Physical Society of Japan, Journal*, vol. 38, Jan. 1975, p. 252-256. 6 refs.

The flow field behind an attached shock wave produced by a wedge fixed in a uniform stream of a gas containing small dust particles is examined theoretically by a perturbation method. The shock wave causes a deviation from an equilibrium state and bends downstream as a result of interaction with Mach waves. For downstream an entropy layer is formed near the surface of the wedge, across which the pressure is constant but other flow variables change appreciably. Numerical values of the temperature and the pressure of the gas are given for a few cases showing that these variables take then maximum in the relaxation region next to the shock wave. (Author)

A75-23348 # The institutionalization and the general problems of air traffic (Institucionalidad y problemática general de la circulación aérea). E. Lallemand Abella. *Ingeniería Aeronáutica y Astronáutica*, vol. 26, July-Aug. 1974, p. 17-28; Discussion, p. 29-32. In Spanish.

Questions regarding the establishment of international and national regulations of air traffic are discussed along with organizational details concerned with the control of civil and military aircraft operations. Attention is given to conditions in eight countries of Western Europe. Operational air traffic control problems are considered, taking into account questions of navigation above the ocean, landing procedures, the separation of air traffic, types of control areas, and the radar equipment used. Undesirable aspects of air traffic related to noise and air pollution effects are also discussed. G.R.

A75-23349 # Aids to air navigation (Ayudas a la navegación aérea). A. Martínez Sarandeses. *Ingeniería Aeronáutica y Astronáutica*, vol. 26, July-Aug. 1974, p. 33-50; Discussion, p. 50-52. In Spanish.

The pilot in an aircraft which during its flight is physically isolated above the surface of the earth requires assistance to determine the position of the aircraft and to reach his destination. The navigation aids available to the pilot in the navigation of the aircraft are considered, giving attention to the systems NDB/ADF, RMI, VOR, DME, the navigational system used in Spain, hyperbolic navigation, and systems employed for aircraft approach and landing. Aspects of Doppler navigation are also discussed and an evaluation of the comparative advantages of the various systems is provided. G.R.

A75-23366 # Handbook for aircraft mechanics /3rd revised and enlarged edition/ (Spravochnik aviatsionnogo tekhnika /3rd revised and enlarged edition/). P. S. Shevel'ko, A. E. Akindeev, V. G. Braga, V. D. Konstantinov, S. S. Sukhanov, and Iu. P. Tikhomirov. Moscow, Voenizdat, 1974. 592 p. 62 refs. In Russian.

The present work has compiled in a concise format the principle concepts of aeronautical engineering, including a review of fundamentals of various theoretical branches of science on which the techniques of aircraft design are based. Thus, besides an exposition of the basic concepts of flight mechanics (for both fixed and rotary wing aircraft) and a description of the chief types of aircraft power plants and the basic equipment used in aircraft communication, navigation, and control, there is also given a review of basic physics, strength of materials, and electronics. Additional reference data is also supplied on the properties of metals and alloys, oils, greases, pastes, fuels, and lubricants used in aircraft technology. P.T.H.

A75-23369 # Aircraft switching devices: Fabrication technology and installation (Kommutatsionnaia apparatura letatel'nykh apparatov: Tekhnologiya izgotovleniya i oborudovanie). L. N. Moskovkin, I. V. Borisov, and I. I. Zakharov. Moscow, Izdatel'stvo Mashinostroenie, 1974. 256 p. 55 refs. In Russian.

The methods used in the production of electrical switching and protective devices are analyzed. Attention is given to the technological processes used in assembling the components of aircraft electrical systems. The classification of assembly processes and quality control of finished products are discussed. Coil-fabrication technology is analyzed in detail. Consideration is given to the assembly and quality control of other units, including relays, contactors, microswitches, and bunched conductors. Mechanized methods used in assembly operations are also discussed. A.T.S.

A75-23375 # Exploitation of air conditioning systems for passenger aircraft (Ekspluatatsiia sistem konditsionirovaniia vozdukha passazhirskikh samoletov). I. N. Antipenko, N. V. Danilov, and V. I. Kuznetsov. Moscow, Izdatel'stvo Transport, 1974. 137 p. 5 refs. In Russian.

The present work makes various recommendations concerning the control of temperature, humidity, and pressure conditions in all types of passenger aircraft, including airplanes flying at both subsonic and supersonic speeds, and helicopters. Basic schemes for control of cabin conditions are described along with various kinds of special equipment. P.T.H.

A75-23395 # Theory of astronomical correction (Teoriia astronomicheskoi korrektsii). A. M. Kamenskii. Moscow, Izdatel'stvo Mashinostroenie, 1974. 220 p. 24 refs. In Russian.

A theory is developed for the linear astronomical correction of navigational and flight parameters of flight vehicles. Particular attention is given to the celestial guidance equations and to the error equations of astronomical correction methods. The influence of the errors of astronomical methods on the accuracy of astronomical

correction of flight vehicle coordinates and on the parameters defining vehicle orientation is assessed, and the kinematics of an astronomical direction finder during the correction procedure is studied. V.P.

A75-23397 # Automatic balancing of rotors in high-speed machines (Avtomaticheskoe uravnoveshivanie rotorov bystrokhodnykh mashin). A. A. Kuindzhi, Iu. A. Kolosov, and Iu. I. Naroditskaia. Moscow, Izdatel'stvo Mashinostroenie, 1974. 152 p. 65 refs. In Russian.

Methods for eliminating resonance modes and high vibration levels in turbomachines are considered, and the need for automatic rotor balancing is discussed. Methods are described by which automatic balancing is accomplished through changing the position of the rotor's principal central axis of inertia (forced centering). Experiments were performed on balancing a flexible rotor during operation. A.T.S.

A75-23412 Cost savings in the application of P/M titanium and P/M aluminum alloys. S. Abkowitz (Dynamet Technology, Inc., Burlington, Mass.). In: National Powder Metallurgy Conference, Boston, Mass., April 8-10, 1974, Proceedings. Conference sponsored by the Metal Powder Industries Federation and American Powder Metallurgy Institute. Princeton, N.J., Metal Powder Industries Federation (Progress in Powder Metallurgy. Volume 30), 1974, p. 85-101.

Recent developments in the powder metallurgy of titanium and aluminum alloys for aircraft applications are reviewed and titanium powder production techniques are briefly described. The outline presented covers the pressing and sintering characteristics for titanium powders and alloys, the mechanical properties of pressed and sintered C.P. titanium powder as well as of pressed and sintered Ti-6Al-4V alloy made from elemental powder additions, the typical properties of these alloys, machinability, the forging preforms and types of pressed and sintered titanium parts made by isostatic compaction, and the isostatic pressing parameters for Al-601 and Al-201 alloys. Isostatic compaction is shown to be a cost saving technique using less material and eliminating material waste and extensive machining operations. S.D.

A75-23421 # The Il-18 aircraft /2nd enlarged and revised edition/ (Samolet Il-18 /2nd enlarged and revised edition/). A. N. Kuznetsov, V. Ia. Pokrovskii, V. M. Polikushin, and L. A. Premet. Moscow, Izdatel'stvo Transport, 1974. 348 p. In Russian.

The Il-18 is a medium- to long-range transport aircraft powered by four Al-20 turboprop engines. Five modifications of the basic aircraft, with passenger capacities from 80 to 122, have been developed. The present exposition concentrates mainly on the Il-18C, which can carry 110 passengers and has a maximum takeoff weight of 61,200 kg. Basic information is given concerning the aircraft and the operation of its main systems. The airframe construction, including the fuselage, wings, and tail surfaces, are described. Other systems discussed include the landing gear, the control system, and the hydraulic, fire-control, deicing, and cabin-pressurization systems. Consideration is given to the construction of the engine nacelles and airscrews and to the engine, fuel, and oil control systems. A.T.S.

A75-23423 # Aircraft control surface actuators (Privod rulevykh poverkhnostei samoletov). V. I. Goniotskii, F. I. Sklianskii, and I. S. Shumilov. Moscow, Izdatel'stvo Mashinostroenie, 1974. 320 p. 58 refs. In Russian.

The design characteristics of modern control-surface actuators are examined, along with methods of calculating and analyzing the control systems of mechanical, hydromechanical, electrohydraulic, and electrohydraulic actuators. Particular attention is given to multichannel redundant systems and to questions associated with the dynamic characteristics and stability of actuators. Engineering methods of calculating the structural parameters of the principal actuator elements are outlined. V.P.

A75-23428 # Reliability of airframes (Nadezhnost' planera samoleta). P. A. Solomonov. Moscow, Izdatel'stvo Mashinostroenie, 1974. 320 p. 31 refs. In Russian.

The book deals essentially with the reliability and service life of aircraft. The characteristics of the aerodynamic and thermal loads acting on airframe elements are examined, along with methods of ensuring reliability during the planing stage and serial production. Aircraft maintenance and inspection methods are outlined, with particular reference to methods of restoring faulty elements and systems. Criteria for quantitative assessment of aircraft safety are examined, and the basic characteristics of aircraft reliability are discussed. V.P.

A75-23436 Noise legislation and regulations. M. J. Crocker (Purdue University, West Lafayette, Ind.). In: Reduction of machinery noise; Proceedings of the Short Courses on Fundamentals of Noise Control and Reduction of Machinery Noise, Purdue University, West Lafayette, Ind., May 13-17, 1974. Courses sponsored by Purdue University. West Lafayette, Ind., Purdue University, 1974, p. 69-75. 15 refs.

A review of federal, state, and local noise abatement laws is presented. Federal legislation described includes the Walsh-Healy Act, the Occupational Safety and Health Act, FAA noise standard regulations, and the Noise Control Act of 1972. Some state laws regulating motor vehicle and airport noise and awarding compensation for occupational hearing losses are discussed, and some city noise codes are briefly noted. Noise surveys and compliance plans developed by the Federal Environmental Protection Agency and the Occupational Safety and Health Administration are outlined, and permissible noise exposures under the Walsh-Healy Act are appended. F.G.M.

A75-23439 S-3A Design-to-a-Cost program. W. L. Richter (Lockheed-California Co., Burbank, Calif.). *ASM, SME, and ASNT, Western Metal and Tool Exposition and Conference, Los Angeles, Calif., Mar. 11-15, 1974, SME Paper MM74-710.* 13 p.

This paper describes the workings and results of the Design-to-a-Cost program conducted in support of the Lockheed S-3A design development. The most significant elements were the development of specific unit production cost targets prior to commencement of design, the tracking and cost control of the developing designs to these targets and the timely reporting of evolving results to design groups and project management. The program, in addition to having been very effective in the actual control of production unit costs during design to established objectives, also demonstrated that a viable design-to-a-cost program can be conducted with relatively small manpower expenditures. (Author)

A75-23441 N/C tape laying - Tomorrow's future today. W. B. Goldsworthy (Goldsworthy Engineering, Inc., Los Angeles, Calif.). *ASM, SME, and ASNT, Western Metal and Tool Exposition and Conference, Los Angeles, Calif., Mar. 11-15, 1974, SME Paper MS74-729.* 10 p. Army-sponsored research.

An automated gantry type tape-laying machine with six-axis digitizing unit is developed for manufacturing helicopter rotor blades made of fiber-reinforced plastic composites. The digitizer uses an optical line-follower allowing it to trace the routes and outrigger sensors spanning the tape width help assure perpendicularity to a changing contour. However an operator is required to take whatever overriding action is necessary to smooth the overall tape-laying program. Blades with 3-inch wide preimpregnated graphite fiber tape (and possibly boron fiber tape) are reported to be lighter, yet stiffer than metal and to improve the in-flight performance of helicopters by up to 30 percent. S.D.

A75-23443 Cost-competitive B-1 composite secondary structures. L. M. Lackman and F. F. MacDonald (Rockwell International Corp., Aircraft Div., Los Angeles, Calif.). *ASM, SME, and ASNT, Western Metal and Tool Exposition and Conference, Los Angeles, Calif., Mar. 11-15, 1974, SME Paper EM74-732.* 8 p.

The paper will review the potential payoffs associated with the development and utilization of cost-competitive composite secondary structures for the production aircraft. Total potential cost and weight savings are delineated, and the status of a precursor IR&D program will be reviewed. The paper discusses design and manufacturing philosophy and procedures necessary to achieve production composite structures which are equal to, or less in, cost than corresponding metal structures. (Author)

A75-23457 # A state-variable design approach for a high-performance aerospace vehicle pitch orientation system with variable coefficients. R. A. Ray, E. V. Mirmack (USAF, Washington, D.C.), and C. H. Houpi (USAF, Institute of Technology, Wright-Patterson AFB, Ohio). In: Annual Southeastern Symposium on System Theory, 6th, Baton Rouge, La., February 21, 22, 1974, Proceedings. Baton Rouge, Louisiana State University, 1974.

3 p. 8 refs.

A state-variable design approach using the quadratic PI is presented for designing a pitch attitude control system for the X-15 aircraft which is insensitive to parameter variations over a given range of flight conditions. A desired control ratio was the design criterion, and a fixed-gain feedback solution was obtained. In comparison with the system designed by Ray (1973), a significant gain reduction is achieved along with a large decrease in response time, and a zero steady-state error is obtained for all FCs. P.T.H.

A75-23459 # Performance survey of the air traffic control radar beacon system. B. Rubinger (U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.). In: Annual Southeastern Symposium on System Theory, 6th, Baton Rouge, La., February 21, 22, 1974, Proceedings. Baton Rouge, Louisiana State University, 1974. 5 p.

Results of a survey are presented and interpreted in which it was attempted to assess the operational deficiencies and determine the impact of an ongoing program of system improvements to the radar beacon system used in air traffic control. Operation of the system, which provides azimuth, range, identity, and altitude information on properly equipped aircraft, is reviewed. A total of 36 facilities considered representative of the entire system participated in the survey, which consisted in filling out a questionnaire on main types of operational problems encountered with the radar beacon system. The most common form of system degradation, accounting for 24.0% of the complaints, was the loss of a target for a short period of time. This is followed by broken targets, 21.3%; ring around (triggering of a transponder at all bearings) 18.3%; target lost long time, 15.5%; and false targets, 9.0%. It was revealed that 20.6% of the reports on loss of beacon coverage involved aircraft traveling straight and level, while 18.8% involved maneuvering aircraft. P.T.H.

A75-23594 VSCF starter generator. D. L. Lafuze (General Electric Co., Aircraft Equipment Products Div., Utica, N.Y.). In: Power Electronics Specialists Conference, Murray Hill, N.J., June 10-12, 1974, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1974, p. 327-333. Contract No. N00421-72-C-6702.

The VSCF system described is an all ac conversion system plus a wound rotor salient pole machine. During the start, the system functions as a brushless dc machine with 400 Hz supplied to it. After the start is completed, the output of the machine, now operating as a synchronous generator driven at variable speed, is converted to constant frequency (VSCF) 400 Hz power. No major circuit changes are required to change the mode of operation. The block diagram, power circuit diagram, and diagrams of the excitation circuits, dc machine analogy, and machine frequency at various supplies are given and discussed. V.P.

A75-23614 Diagonalization of the bearing matrix - A systematic method for the analysis of rotor-bearing dynamics. C. H. T. Pan (Shaker Research Corp.). In: International Gas Bearing Symposium, 6th, Southampton, England, March 27-29, 1974,

Proceedings.

Cranfield, Beds., England, British Hydromechanics Research Association, 1974, p. C3-33 to C3-44. 5 refs.

Dynamic perturbation analysis of rigid rotor bearing systems involves linear coupling up to the fourth order. By diagonalizing the impedance matrix of the bearing (by solving a characteristic equation), the problem is reduced to one-dimensional treatment of each of the several normal modes, each of which is an elliptic orbit having the same or the opposite sense of rotation as that of the rotor. This approach yields eigenvalues which may be regarded as equivalent stiffness and damping coefficients and corresponding eigenvectors that describe the normal modes. Resonance and critical speed may be regarded as mechanisms for selective amplification of the normal modes. Dynamic problems can be solved by expressing both excitations and motions in terms of normal mode components. The eigenvalue problem of a second-order system can be solved in analytical form. Higher order systems can be solved numerically, or if coupling is weak, by iterative techniques. V.P.

A75-23615 The steady state and dynamic behaviour of the turbo-bearing. J. Bennett and H. Marsh (Durham, University, Durham, England). In: International Gas Bearing Symposium, 6th, Southampton, England, March 27-29, 1974, Proceedings.

Cranfield, Beds., England, British Hydromechanics Research Association, 1974, p. C4-45 to C4-55. Research supported by the Science Research Council.

The turbo-bearing is an externally pressurized gas bearing with inclined supply holes, so that the gas enters the bearing clearance with a high angular momentum. There is a change of angular momentum for the gas and this produces a driving torque on the rotor. The paper describes a method for designing the turbo-bearing and the theory is confirmed by the experiments. It is shown that the inclined supply holes have no adverse effect on the load carrying capacity or stiffness of the bearing. The onset of half speed whirl has been investigated by driving the rotor to high speeds and it has been shown that the whirl onset speed is dependent on the direction of rotation. (Author)

A75-23638 # Load distribution on threads of titanium tension nuts and steel bolts. N. Motosh (Asyut University, Asyut, Egypt). (American Society of Mechanical Engineers, Paper 74-DE-N, 1974.) ASME, Transactions, Series B - Journal of Engineering for Industry, vol. 97, Feb. 1975, p. 162-166.

The pressure distribution among thread turns in a titanium tension nut as used in the aircraft industry is calculated. Deformations due to loading are determined by calculating the relative change in pitch between nut and bolt threads due to axial deformations, changes due to radial deformation of nut and bolt elements, and changes due to bending of threads and of the nut body. Iteration is used to determine load distribution. It is noted that the use of tension nuts made of materials such as titanium, having a lower modulus of elasticity than bolt steel, results in a uniform distribution of load on thread turns. F.G.M.

A75-23649 # Automatic Test System Jet Engine Accessories. G. Kelly (RCA, Government Communications and Automated Systems Div., Burlington, Mass.). In: Automatic testing '74; Proceedings of the Conference and Exhibition, Brighton, England, November 5-8, 1974. Session 3. Newport Pagnell, Bucks., England, Network, 1974, p. 3-45 to 3-56.

A description is given of the ATSJE (Automatic Test System Jet Engine Accessories) system which was developed to provide automatic testing of jet-engine accessories such as fuel controls, fuel pumps, spray nozzles, constant-speed drives, hydraulic pumps, hydraulic pump/motors, and hydraulic motor starters. The ATSJE system has been used for automatic testing of J-79 engine accessories, resulting in time savings of 75% for testing main fuel controls and 50% for testing afterburner fuel controls, when compared to manual testing. The main components of the ATSJE system, including the hydraulic test stand, the control and display

panel, the central computing equipment, and the system software, are described. A notable feature of the system is its use of generic test stands which are configured from basic modules to provide a wide variety of test parameters for different main and afterburner fuel controls. A.T.S.

A75-23667 # Evaluation of stiffness coefficients for fiber-reinforced laminated composites. A. K. Bath and P. K. Sinha (Indian Space Research Organization, Vikram Sarabhai Space Centre, Trivandrum, India). In: Seminar on the Role of Computers in Structural Analysis, Design and Optimisation, 2nd, Bangalore, India, June 13, 14, 1974, Proceedings. Bangalore, India, National Aeronautical Laboratory, 1974, p. SA-119 to SA-135. 8 refs.

Applying the strain energy principle, the stiffness matrix is derived for a triple layered fiber-reinforced laminate having fiber orientations (beta, alpha, -beta). The stiffness coefficients are determined for laminated composites, consisting of such triple layers. The present formulation is more general in nature, as it permits analysis for arbitrary stacking sequence. A few numerical results are presented for commonly used fiber-reinforced composites, employing the effective micromechanics properties as summarized by Tsai (1964) for unidirectional composites. (Author)

A75-23693 # Areas of ECM application, opportunities and limitations. A. H. Meleka (Rolls-Royce /1971/, Ltd., Filton, Bristol, England). In: Electro-machining in the workshop; International Symposium, 4th, Bratislava, Czechoslovakia, September 18, 19, 1974, Proceedings. Bratislava, Dom Techniky SVTS, 1974, p. 50-52.

It is pointed out that the success in electrochemical machining (ECM) in the jet engine industry has not been matched by an equivalent use of ECM in other fields of the engineering industry. An investigation is conducted regarding basic difficulties of ECM application, taking into account areas of competition with other processes. Shaping is by far the widest area of application of ECM. Attention is given to questions of accuracy, machine tool cost, plant utilization, the 'memory effect', and approaches for overcoming existing difficulties. Drilling operations are considered along with turning, grinding, electrochemical deburring, and EC broaching. G.R.

A75-23794 Analytic construction of function for conformal transformation of exterior of circle onto exterior of arbitrary wing profile. N. M. Monakhov and V. F. Startsev. (*Aviatsionnaia Tekhnika*, vol. 17, no. 2, 1974, p. 18-24.) *Soviet Aeronautics*, vol. 17, no. 2, 1974, p. 12-17. Translation.

A75-23797 Analysis of frequency error of airplane descent rate measured by a laser. V. A. Puzyrev and G. P. Dement'eva. (*Aviatsionnaia Tekhnika*, vol. 17, no. 2, 1974, p. 38-42.) *Soviet Aeronautics*, vol. 17, no. 2, 1974, p. 29-32. Translation.

An indirect method for measuring height during the final descent phase of an aircraft (from a height of 30 m) is proposed. The height is determined not by direct measurement, but by measuring the parallactic angle formed by the directions from the required point of the flight path to the ends of a base line located in front of the runway. Using a scanning laser, the parallactic angle can be measured with high precision. It is shown that for a scanning rate on the order of 50 rps, the error in the determination of the rate of descent is plus or minus 3.6 cm/sec. V.P.

A75-23798 Substantiation of discrete-continuum low-aspect-ratio wing structural analysis scheme. M. B. Vakhitov and N. G. Lariouov. (*Aviatsionnaia Tekhnika*, vol. 17, no. 2, 1974, p. 43-47.) *Soviet Aeronautics*, vol. 17, no. 2, 1974, p. 33-36. 9 refs. Translation.

The finite element method of designing low-aspect-ratio wings is based on the use of a discrete design diagram. For wings with a large

number of ribs, the natural box (formed by the longitudinal and lateral assemblies) must be enlarged in the span direction. To avoid the error resulting from this enlargement, a discrete-continuum (with respect to the lateral assembly) diagram is proposed, in which the wing is represented as a system of compartments between reinforced ribs. The latter are treated as discrete ribs, while the normal ribs in a compartment are treated as continual ribs (i.e., continuously distributed along the length of the compartment). The improved accuracy of the diagram proposed is demonstrated by examples. V.P.

A75-23801 Analysis of thin-wall circular fuselage in damage zone. B. N. Kornev. (*Aviatsionnaia Tekhnika*, vol. 17, no. 2, 1974, p. 57-61.) *Soviet Aeronautics*, vol. 17, no. 2, 1974, p. 45-48. Translation.

An arbitrarily loaded thin-walled fuselage of constant circular cross section is examined in which part of the stringers have faults in the form of intersections (discontinuities) with strips of the fuselage skin. A faulty area is understood to mean a portion of the structure containing stringer discontinuities arbitrarily distributed over the fuselage contour and length. The solution of the problem of determining the stress-strain state in a faulty area is reduced to the integration, in normal coordinates, of systems of second-order differential equations with constant coefficients. An expedient is devised for converting inhomogeneous boundary conditions to homogeneous ones. V.P.

A75-23802 On empennage stability. V. A. Pavlov. (*Aviatsionnaia Tekhnika*, vol. 17, no. 2, 1974, p. 62-66.) *Soviet Aeronautics*, vol. 17, no. 2, 1974, p. 49-53. Translation.

By analyzing the strain state produced in multiply hinged tail surfaces by a deflection of the rudder, it is shown that due to rotation about hinge axes bent by external forces, the rudder experiences an additional load in its own plane. This leads to a flexure of the rudder in its plane of maximum rigidity. With increasing stabilizer curvature, the forces increase in proportion with the deflection of the rudder. At a stabilizer curvature that is critical for a given angle of deflection of the rudder, the rudder/stabilizer system becomes unstable in the sense that the rudder deflection angles assume opposite signs. Using Timoshenko's theory of beam stability in plane bending, it is shown that for certain ratios of rudder to stabilizer rigidity, external loads may lead to this type of instability even in modern aircraft if the rudder deflection angle exceeds a certain critical value. V.P.

A75-23806 'Ring vortex' energy losses during centrifugal fan operation in low output regimes. V. I. Isaev. (*Aviatsionnaia Tekhnika*, vol. 17, no. 2, 1974, p. 84-88.) *Soviet Aeronautics*, vol. 17, no. 2, 1974, p. 68-71. 5 refs. Translation.

A75-23809 Stress-strain state and springback in elastic-plastic torsion of profiles with open cross section contour. Iu. P. Kataev. (*Aviatsionnaia Tekhnika*, vol. 17, no. 2, 1974, p. 98-104.) *Soviet Aeronautics*, vol. 17, no. 2, 1974, p. 80-85. Translation.

A75-23810 Predicting instrumental reliability of automated aircraft system monitoring based on critical parameter. G. M. Zagrutdinov. (*Aviatsionnaia Tekhnika*, vol. 17, no. 2, 1974, p. 105-111.) *Soviet Aeronautics*, vol. 17, no. 2, 1974, p. 86-91. Translation.

A75-23816 Analytic specification of compressor characteristics. Kh. S. Gumerov, A. Ia. Magadeev, A. S. Gavrilov, L. Kh. Iuldybaev, and A. M. Akhmedzhanov. (*Aviatsionnaia Tekhnika*, vol. 17, no. 2, 1974, p. 128-131.) *Soviet Aeronautics*, vol. 17, no. 2, 1974, p. 113-115. Translation.

Means of expressing compressor characteristics in a form suitable for programmed computation of gas-turbine characteristics are examined. An analytical method is proposed in which the compressor characteristics are expressed in the form of two polynomials. It is shown that the proposed representation and coordinates make it possible to simplify the configuration of the compressor pressure leads and to achieve a satisfactory approximation accuracy in engineering calculations. V.P.

A75-23817 Thermodynamics of multistage air-cooled gas turbine. E. N. Bogomolov. (*Aviatsionnaia Tekhnika*, vol. 17, no. 2, 1974, p. 132-140.) *Soviet Aeronautics*, vol. 17, no. 2, 1974, p. 116-123. Translation.

Expressions for the efficiency and the heat recovery factor of an open-loop air-cooled gas turbine are derived from the parameters of the individual stages, assuming that the mixing of the cooling air with the main flow is completed within the flow area of a stage. It is shown that the thermodynamic process in such a turbine may be characterized by three types of efficiency: one that reflects the influence of cooling on the energy conversion in the turbine; another that reflects the contribution of the coolant to effective-power generation, and a third that reflects the degree of conversion of the gas and coolant energies to effective power. Several particular cases, including a closed-loop air-cooled turbine and an uncooled turbine with identical stage parameters are examined. V.P.

A75-23818 Study of annular nozzle cascades with different 'reverse' vane twist. V. A. Derevenko and Iu. I. Mitushkin. (*Aviatsionnaia Tekhnika*, vol. 17, no. 2, 1974, p. 140-143.) *Soviet Aeronautics*, vol. 17, no. 2, 1974, p. 124-126. 8 refs. Translation.

A75-23819 Calculation of flutter boundary of dynamically nonuniform profile cascades. N. V. Dovzhenko. (*Aviatsionnaia Tekhnika*, vol. 17, no. 2, 1974, p. 143-147.) *Soviet Aeronautics*, vol. 17, no. 2, 1974, p. 127-130. 6 refs. Translation.

The application of the dynamic nonuniformity (difference in blade frequency) of turbine bladings to the suppression blade flutter in axial-flow compressors is examined. A method of determining the coefficients of the matrix in the flutter equation with allowance for the interaction (only) between neighboring blades is proposed. The method is shown to reduce appreciably the difficulties involved in the computation of all the roots of higher-order algebraic equations with complex coefficients. In most cases, the roots can be computed with the aid of standard algorithms. The aeroelastic stability of two different compressor-stage impeller wheels is calculated as an example. V.P.

A75-23821 Averaging of nonuniform flow in turbo-machine flow traverses. A. P. Tunakov. (*Aviatsionnaia Tekhnika*, vol. 17, no. 2, 1974, p. 149-152.) *Soviet Aeronautics*, vol. 17, no. 2, 1974, p. 133-136. 6 refs. Translation.

Sedov's (1972) formulas are reduced to a form convenient for numerical integration of traversing data. The expressions obtained yield the averaged flow parameters for the entire cross section. A relation between the flow parameters at the mean diameter and the parameters averaged over the entire cross section, based on the use of a nonuniformity factor, is proposed. V.P.

A75-23822 Compressor and turbine characteristic representation in algorithm for calculating turbojet engine throttling characteristics. O. K. Iugov and O. D. Selivanov. (*Aviatsionnaia Tekhnika*, vol. 17, no. 2, 1974, p. 152-157.) *Soviet Aeronautics*, vol. 17, no. 2, 1974, p. 137-140. Translation.

A75-23855 # Data transmission by optical fibers aboard aircraft (Transmissions de données par fibres optiques à bord des avions). G. de Corlieu and T. A. Hawkes (Thomson-CSF, Division Equipements Avioniques et Spatiaux, Issy-les-Moulineaux, Hauts-de-Seine, France). *Revue Technique Thomson-CSF*, vol. 6, Dec. 1974, p. 1205-1224. In French. Research supported by the Direction des Recherches et Moyens d'Essais.

The tendency to data exchange aboard aircraft in digital form will be accelerated by the use of systems such as electronic visualization, area navigation, fly-by-wire, and time multiplexing. Multimode optical fibers offer several advantages for transmitting such information, including immunity to electromagnetic interference, the absence of electromagnetic radiation from the transmission lines, light weight, and wide transmission bandwidth. The present study covers the power balance for optical transmission of digital data, possible communications-link structures, modulation, and synchronization. The use of GaAs light-emitting diodes as the transmitters in the data-exchange system is suggested. The most suitable detectors would be PIN diodes. The transmission medium would be multimode fiber bundles containing 50-100 fibers having a large numerical aperture and moderately high losses. A.T.S.

A75-23887 Flexibility objectives for real-time telemetry processing systems. J. W. Rymer (U.S. Naval Air Test Center, Patuxent River, Md.). In: International Telemetering Conference, Los Angeles, Calif., October 15-17, 1974, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1974, p. 164-181. 21 refs.

A generalized real-time telemetry processing system model is developed in four blocks: demod/synchronization, data channel, processing/control, and display. Flexibility objectives are stated for each block and illustrated with respect to an existing real-time telemetry processing system. Features and tradeoffs are discussed for each block, along with references to the growing and significant body of such systems already existing and currently under development. Assumptions include: (1) multimillion-dollar test vehicles or components thereof, (2) that the useful life span of the system will extend at least until 1980, (3) that the decision to go with real-time and/or online post-test handling has been made, and (4) that reliability and dollars are of sufficient concern to preclude major fractions of the hardware being developed uniquely for the target system. S.J.M.

A75-23888 Evolution of the Douglas flight-test data system. L. D. Crowley (Douglas Aircraft Co., Long Beach, Calif.). In: International Telemetering Conference, Los Angeles, Calif., October 15-17, 1974, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1974, p. 182-195.

Development of improved data acquisition and processing systems retaining overall compatibility with existing communications and ground station systems is discussed. The baseline digital data system for recording airborne instrumentation inputs is described, as well as the smaller-scale mini digital data system and asynchronous buffer system, which buffers, reformats, and clocks high burst rate signals into compatible data streams. Future systems include the digital subcom unit and digital add-on unit. Data transmission and communications systems described are the baseline telemetry/microwave link and the remote terminal facility in Yuma, Arizona. The functions of the baseline flight control and data center are detailed, and present and future modifications in computer hardware and software are outlined. F.G.M.

A75-23889 The future of real time telemetry systems. R. P. LeCann (Grumman Data Systems Corp., Bethpage, N.Y.). In: International Telemetering Conference, Los Angeles, Calif., October 15-17, 1974, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1974, p. 196-200.

The development of an automated telemetry system for real time testing of aerospace vehicles is outlined. Desirable parameters

considered for software systems include separation of preprocessing and analysis functions, use of a multilevel priority structure and option dependent programming, and incorporation of debug facilities and real time status checks for all critical functions within the system. Hardware design using multistream configurations, 1 Mbps data rates, microprogrammable processors, and high speed remote intelligent terminals is described, and systems management to make fully reliable and accurate use of the inherent capabilities of the entire complex is discussed. F.G.M.

A75-23902 * An integrated PCM data system for full scale aeronautics testing. D. R. Reynolds (NASA, Ames Research Center, Moffett Field, Calif.). In: International Telemetering Conference, Los Angeles, Calif., October 15-17, 1974, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1974, p. 347-356. 7 refs.

An integrated PCM data system is being developed at Ames Research Center to gather test data on advanced STOL propulsive lift, VTOL, rotary wing, and V/STOL control systems concepts as they pass through wind-tunnel, test-stand, flight-simulator and flight-test phases. Identical airborne signal conditioning and PCM encoding is used on test aircraft and wind tunnel models. An 80,000 word/second PCM installation will be the first all PCM-instrumented rotary wing development project. The system uses both dedicated and time-shared computers for fast data analysis with maximum use of resources. This system development shows one way to bring separate data user groups together over a common data base, while sharing computing resources for minimum cost. (Author)

A75-23912 * Aeroflight communications and RF nav aids. D. S. Lilly (NASA, Johnson Space Center, Houston, Tex.). In: International Telemetering Conference, Los Angeles, Calif., October 15-17, 1974, Proceedings. Pittsburgh, Pa., Instrument Society of America, 1974, p. 496-502.

The principal operational requirements of the Space Shuttle Program concept of a low cost reliable and reusable orbital vehicle are outlined, and the aerial navigation and landing systems selected for the vehicle are discussed, along with their interfaces with the control and navigation systems. It is shown how the atmospheric flight systems were developed by adapting well-proven designs to a new application. Design improvements were held to a minimum, with no new concepts or extensive modifications required that might compromise previous system experience or qualification status. Newest concepts, such as digital designs, serial digital control, etc., as well as integration of software and hardware were accomplished to control and manage time critical processes, such as BIT and redundancy management. Appropriate planning and careful appraisals preceded the selection of a system. V.P.

A75-23942 Study of materials and nonmetallic coatings for erosion and wear resistance (Etude de matériaux et revêtements non métalliques résistant à l'érosion et à l'usure). G. Sertour, M. Armbruster, H. Bernard, and P. Renard (Société Nationale Industrielle Aéronautique, Paris, France). *Association Technique Maritime et Aéronautique, Bulletin*, no. 74, 1974, p. 357-367; Discussion, p. 368, 369. In French.

The present work summarizes the results of some research initially carried out in order to develop cavitation-resistant and self-lubricating materials for an experimental hydrofoil. An original technique of overmolding with a plastic material (polyurethane resin) was developed for cavitation-resistant coatings. This coating offers, besides excellent cavitation resistance, good properties against rain and sand erosion, and it could be applied for helicopter blade protection. Heavy load selection tests led to some self-lubricating materials (PTFE, graphite-stellite) whose sea water compatibility seems satisfactory. Some of the testing equipment used in this research is briefly described. P.T.H.

A75-23945 Unsteady flow through a turbomachine stage with free vortex shed (Ecoulement instationnaire non linéaire à travers un étage de turbomachine avec émission de nappes tourbillonnaires). J. Corniglion (Centre d'Etude Technique des Industries Mécaniques, Paris, France) and T. S. Luu (CNRS, Laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur, Orsay, Essonne, France). *Association Technique Maritime et Aéronautique, Bulletin*, no. 74, 1974, p. 613-628; Discussion, p. 629. 8 refs. In French.

A method based on the technique of singularities has been developed for calculating the pressure distribution and the aerodynamic forces and moment acting on the blades of a turbomachine stage. The fluid flow through the stage is considered unsteady, two-dimensional and the calculation is based on the hypotheses of an incompressible and irrotational fluid. The Kutta-Joukowski condition is strictly imposed, which leads to a variable circulation around each profile while a free vortex sheet is emitted at the sharp trailing edge. The shape of periodic sheets is correctly evaluated with the effect of all singularities of field. This instantaneous shape of sheets is taken into account for the resolution of field problems attached to the phenomenon. This new approach with the exact Kutta-Joukowski condition complete the possibilities to reach the incompressible potential flow. Numerical results are presented with or without free vortex shed. (Author)

A75-23946 Flow determination at the exit of a moving supersonic annular blade cascade (Détermination de l'écoulement issu d'une grille annulaire mobile supersonique). J. Reboux (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Association Technique Maritime et Aéronautique, Bulletin*, no. 74, 1974, p. 631-646; Discussion, p. 647-649. In French.

The flow determination at the exit of a high hub to tip ratio supersonic compressor is discussed in this paper. The test compressor and the measurements are described. The best position of the exit section of measurement, vs the speed of rotation, is defined by two conditions: conservation of mass flow and good agreement between measured and calculated enthalpy increases. (Author)

A75-23947 Experimental study of the unsteady flow through a turbomachine stage (Etude expérimentale de l'écoulement instationnaire dans un étage de turbomachine). J. C. Jouannet and J. Corniglion (Centre d'Etude Technique des Industries Mécaniques, Paris, France). *Association Technique Maritime et Aéronautique, Bulletin*, no. 74, 1974, p. 651-677; Discussion, p. 678-680. 15 refs. In French.

The present work describes an experimental facility designed to test some theoretical investigations of the unsteady flow through two blade cascades in relative motion under the hypothesis of a perfect, incompressible and inviscid fluid. An experimental model of a centrifugal turbomachine was constructed with which flow characteristics close to those of the theoretical investigation were obtained. Interpretation of some test results showed a marked effect of the viscous wake, characterized by a flow irregularity coefficient, on the amplitude of the unsteady aerodynamic forces. Study of the correlation among the signals from pressure probes revealed the existence of acoustic waves contributing to the aerodynamic forces. An attempt at a linear correlation between the amplitude of aerodynamic forces and the flow irregularity coefficient made possible an estimate of the contribution from the effect of the wake and the acoustic waves. P.T.H.

A75-23962 * # Measurements of supersonic jet aircraft wakes in the stratosphere. N. H. Farlow, V. R. Watson, M. Loewenstein, K. L. Chan (NASA, Ames Research Center, Moffett Field, Calif.), H. Hoshizaki, R. J. Conti, and J. W. Meyer (Lockheed Research Laboratories, Palo Alto, Calif.). In: International Conference on the Environmental Impact of Aerospace Operations in the High Atmosphere, 2nd, San Diego, Calif., July 8-10, 1974, Preprints. Boston, American Meteorological Society, 1974, p. 53-58. 8 refs.

Progress is reported in an experimental program consisting of making supersonic aircraft wakes visible in the stratosphere so that photographs can be taken which yield wake dimensions vs time, and so that aircraft equipped with instruments which measure key exhaust species can find and penetrate the wakes. The object is to provide verification of fluid dynamic and chemical models. Three available models are summarized, and the experimental methods used are described. The Lockheed model predictions correspond in general most closely to experimental wake cross-sectional areas. NO data are in reasonable agreement with NO predictions, but chemical models are relatively undeveloped, and additional measurements of exhaust products are needed before verification of chemical models becomes possible. However, the overall feasibility of wake visualization for model verification is substantiated. It is emphasized that significant model differences exist that must be resolved before reliable predictions can be made in the wake regimes studied. S.J.M.

A75-23963 # Hydrocarbon emissions from jet engines operated at simulated high-altitude supersonic flight conditions. H. Katzman and W. F. Libby (California, University, Los Angeles, Calif.). In: International Conference on the Environmental Impact of Aerospace Operations in the High Atmosphere, 2nd, San Diego, Calif., July 8-10, 1974, Preprints. Boston, American Meteorological Society, 1974, p. 59-64. 7 refs.

A75-23964 * # Emission calibration of a J-58 afterburning turbojet engine at simulated supersonic, stratospheric flight conditions. J. D. Holdeman (NASA, Lewis Research Center, Cleveland, Ohio). In: International Conference on the Environmental Impact of Aerospace Operations in the High Atmosphere, 2nd, San Diego, Calif., July 8-10, 1974, Preprints. Boston, American Meteorological Society, 1974, p. 65-72. 9 refs.

Emissions of total oxides of nitrogen, unburned hydrocarbons, and carbon monoxide from a J-58 engine at simulated flight conditions of Mach 2.0, 2.4, and 2.8 at 19.8 km altitude are reported. For each flight condition, measurements were made for four engine power levels from maximum power without afterburning through maximum afterburning. These measurements were made 7 cm downstream of the engine primary nozzle using a single point traversing gas sample probe. Results show that emissions vary with flight speed, engine power level, and with radial position across the exhaust. (Author)

A75-23965 # Stratospheric pollution - Aircraft engine emissions in the region above the tropopause as a function of aircraft altitude and tropopause height. C. S. Downie (California, University, Los Angeles, Calif.). In: International Conference on the Environmental Impact of Aerospace Operations in the High Atmosphere, 2nd, San Diego, Calif., July 8-10, 1974, Preprints. Boston, American Meteorological Society, 1974, p. 73-80. 14 refs. Research sponsored by the U.S. Department of Transportation.

A75-23973 # Possible climatic effects of supersonic transports. J. A. Coakley, Jr. and S. H. Schneider (National Center for Atmospheric Research, Boulder, Colo.). In: International Conference on the Environmental Impact of Aerospace Operations in the High Atmosphere, 2nd, San Diego, Calif., July 8-10, 1974, Preprints. Boston, American Meteorological Society, 1974, p. 120-127. 19 refs.

Possible atmospheric perturbations by SSTs, leading to an increase in the concentration of stratospheric aerosols and a decrease in ozone concentration, are examined in light of their effect on the radiation balance of the earth-atmosphere system and consequent changes in the global climate. Using several single column radiative-equilibrium climate models, the effects of increased stratospheric aerosols on the solar energy and terrestrial infrared fluxes are calculated, and two possible estimates for a decrease in the mean

surface temperature are presented. Similar calculations of SST-induced nitric oxide concentrations show that the stratospheric ozone concentration will be reduced, causing changes in the planetary albedo and a decrease in the stratospheric temperature. It is noted that while the predicted changes in global climate are an accurate reflection of SST perturbations, the limitations of single column radiative-equilibrium models prevent an accurate prediction of the magnitude of such changes. F.G.M.

A75-23982 * # First results of a general circulation model applied to the SST-NOx problem. D. M. Cunnold, F. N. Alyea, N. A. Phillips, and R. G. Prinn (MIT, Cambridge, Mass.). In: International Conference on the Environmental Impact of Aerospace Operations in the High Atmosphere, 2nd, San Diego, Calif., July 8-10, 1974, Preprints. Boston, American Meteorological Society, 1974, p. 187-193. 16 refs. Contract No. AT(11-1)-2249; Grant No. NGR-22-009-727.

Results of model runs, one using two-dimensional distribution of NO₂ in the unperturbed stratosphere and another including an additional localized source of NO₂ to approximate the effect of SSTs, are reported. The general circulation model and chemical reactions are described, and corrections in the previous latitudinal and seasonal gradients of total column ozone and the diffusion coefficient in the neighborhood of the tropopause are noted. Excellent agreement with previous observations was obtained. Global distributions of ozone and NO₂ are described and represented in graphs. Results indicate ozone reduction of approximately 16% in the Northern Hemisphere and approximately 8% in the Southern Hemisphere, with the mid-latitude source of NO₂ apparently having a blocking effect on the horizontal transport of ozone, resulting in larger reductions of ozone at high latitudes than at low ones. F.G.M.

A75-23988 Calculation by the singularity method of the characteristics of a cascade in compressible flow without knocking up to the supersonic speed (Calcul des caractéristiques d'une grille en écoulement compressible jusqu'au régime supercritique sans choc par la méthode des singularités). T. S. Luu, G. Coulmy, and A. Grissa (CNRS, Laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur, Orsay, Essonne, France). *Entropie*, vol. 10, no. 58, 1974, p. 17-23. 10 refs. In French.

The method of singularities with discrete distribution developed for the calculation of the compressible flow through a cascade is described, and two examples of its application are given. The compressibility effect is represented by a spatial distribution of the source of the velocity potential. The examples show that the method enables determining the characteristics of a cascade at any subcritical or supersonic flow before the occurrence of shock. The method is demonstrated to be particularly useful in calculating the cascade flow in a transonic regime. The precision and sensitivity of the procedure are also proven. It can be applied to the design of highly cambered turbine cascades. S.J.M.

A75-24000 Aircraft noise in a high-rise city. N. W. M. Ko (University of Hong Kong, Hong Kong). *Journal of Sound and Vibration*, vol. 38, Feb. 22, 1975, p. 512-516. 12 refs.

Some results of measurements of aircraft noise at fifty sites under the flight path in Hong Kong are presented and discussed. The city is characterized by the presence of many tall buildings, and sites were classified as being closed (tall buildings on both sides of road), open (no buildings nearby), or semiclosed (intermediate between open and closed). Time-histories of sound pressure levels are given along with attempts at correlating the time required for the peak pressure to drop 3 and 6 dB(A) with aircraft distance. The shielding effect of tall buildings is evident in the data. P.T.H.

A75-24002 Combining strength and fracture toughness. L. J. McEown (Republic Steel Corp., Canton, Ohio). *Metal Progress*, vol. 107, Mar. 1975, p. 52, 53.

Steel quality for aerospace applications is being enhanced by the use of vacuum-arc-remelted steels in place of air-melted steels. Three of these grades, which feature low inclusion content, more isotropic properties, and low gas content, are HP 9-4-20, HP 9-4-30, and 300M. A fourth grade, HP 310, is currently being developed as a potential commercial alloy for applications requiring strengths higher than that of 300M. The characteristics of the new steels are discussed. G.R.

A75-24003 * NASA vane alloy boasts high-temperature strength. W. J. Waters and J. C. Freche (NASA, Lewis Research Center, Materials and Structures Div., Cleveland, Ohio). *Metal Progress*, vol. 107, Mar. 1975, p. 57, 59, 60.

The higher inlet-gas temperatures in new aircraft turbine engines make it necessary to use improved superalloys in engine design. Such superalloys are provided by WAZ alloys. NASA has explored the Ni-W-Al system in an attempt to find higher-strength nickel-based alloys for use as stator vane materials. Critical performance goals have been met with the new alloy WAZ-16. With suitable protective coatings, WAZ-16 appears to have considerable potential for high-temperature stator vane applications. G.R.

A75-24004 Fracture mechanics' impact on specifications and supply. R. R. Senz (Aluminum Company of America, Pittsburgh, Pa.) and E. H. Spuhler (Aluminum Company of America, Alcoa Center, Pa.). *Metal Progress*, vol. 107, Mar. 1975, p. 64-66.

Problems related to the rapid fracture of high-strength alloys at stresses considerably less than their nominal tensile strengths have led to the development of suitable tests for the evaluation of aluminum structural alloys. Studies aimed at defining the relative toughness of materials are discussed along with the test requirements established and the test costs. Approaches for reducing the test costs are considered and the problems involved in obtaining the needed high-purity aluminum in sufficient quantity are investigated. G.R.

A75-24005 Coatings protect superalloys in gas-turbine applications. A. R. Stetson and V. S. Moore (International Harvester Co., San Diego, Calif.). *Metal Progress*, vol. 107, Mar. 1975, p. 67, 68, 70.

The application of controlled composition coatings is considered along with the significance of the electron-beam physical vapor deposition process and bonding advantages provided by depositing with the aid of sputtering. An investigation of controlled composition reaction sintered (CCRS) aluminide coatings is discussed, giving attention to the use of a duplex process in which an aluminum modifier is applied by a slurry technique. A second approach to CCRS coatings involves a less costly single-cycle process. Experimental data indicate that CCRS coatings have the potential for protecting turbine blade alloys in hostile environments. G.R.

A75-24049 # Digital avionics - An established technology. M. Moulton. *Aircraft Engineering*, vol. 47, Feb. 1975, p. 12-14.

Some basic design considerations for airborne digital electronic systems are discussed, and some modern digital avionic units are briefly described. The general features are described for a head-up digital display, a digital inertial system with anti-submarine patrol capability, a radio navigation system including digital techniques which provides area coverage while temporarily outside beacon range, and a flight control electronics system for a STOL transport using multiple processors to achieve automatic failure survival. Some sensors and flight management systems are also mentioned. P.T.H.

A75-24050 # Head-up and other displays. J. H. Smith and R. A. Chorley (Smiths Industries, Ltd., Aviation Div., Cheltenham, Glos., England). (*Society of Electronic and Radio Technicians and Society of Licensed Aircraft Engineers and Technologists, Symposium on Avionics Today and Tomorrow, University College of Swansea, Swansea, Wales, 1974.*) *Aircraft Engineering*, vol. 47, Feb. 1975, p. 18-22.

The present work gives a description of a typical heads-up display (HUD) installation, giving particular attention to the pilot's display unit, the EHT unit, the pilot's control panel, and the display waveform generator. The development of HUD systems is given a brief historical outline, and some future trends are indicated. The question of system flexibility is investigated along with that of maintainability of electronic displays. P.T.H.

A75-24061 # The determination of the subsonic flow of a Chaplygin gas around a circular profile in the presence of circulation (Zur Ermittlung der zirkulationsbehafteten Unterschallströmung eines Tschaplygin-Gases um ein Kreisprofil). H. Schubert and M. Schleiff (Halle, Universität, Halle, East Germany). *Zeitschrift für angewandte Mathematik und Mechanik*, vol. 55, Jan. 1975, p. 9-17. 18 refs. In German.

The integral equation considered by Grabow (1967) for a circular profile is discussed along with the existence proof for the flow of a Chaplygin gas around a strictly convex profile and the derivation of another integral equation for the determination of the subsonic flow around an entirely smooth profile. Numerical methods for solving the problem are examined, taking into account a procedure reported by Lichtenstein (1931) and the modified Newton approach. Two formulas obtained with the aid of the modified Newton approach are used to compute numerical solutions for a number of simple profiles by means of an ALGOL program. G.R.

A75-24068 A new biaxial tensile testing machine (Une nouvelle machine d'essais de traction biaxiale). M. Lorrain and J.-C. Maso (Toulouse, Institut National des Sciences Appliquées, Toulouse, France). *Revue Française de Mécanique*, 1st Quarter, 1974, p. 53-56. In French.

With the aim of better approximating stress conditions encountered in real structures, a biaxial loading test apparatus has been designed. Its frame is conceived to avoid parasitic bending perturbations, since tensile forces are applied by two independent rigs with rectangular loading axes. Each rig is free to move without friction perpendicular to its loading axis. The centering and orthogonality of the stresses applied to the sample is thus assured throughout the deformation of the sample. The system is particularly suited to extensometric measurement and permits installing the most highly advanced photoelasticity equipment. S.J.M.

A75-24100 # Aero-marine communications by satellite. R. P. Haviland. *ITU Telecommunication Journal*, vol. 42, Feb. 1975, p. 97-104.

A consideration of the problems involved in planning a satellite system to provide aeronautical and marine communications. A modeling approach is used, and the basic flow logic of the model is given. The communications traffic needs for the aircraft and ship services are projected on the basis of the number of aircraft and ships en route at one time (projected according to assumed growth trends) and the traffic needs for each aircraft or ship, including control, company communications, navigational data, and emergency communications. The system is projected to include primary and backup satellites over the Atlantic, Pacific, and Indian oceans, and a master station for each ocean area for system monitoring, location control, etc. An unresolved question is whether the satellites should allow multiple access or be controlled by a single ground terminal. Various factors which affect the optimum frequency allocations for air- and marine-communications satellites are discussed. A.T.S.

A75-24129 The technology of the aircraft MRCA and its systems (Die Technik des Flugzeuges MRCA und seiner Systeme). H. Langfelder (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-63*. 15 p. In German. (MBB-UFE-1104)

The MRCA aircraft is being developed in cooperation between a British, a German, and an Italian aerospace firm as a fighter for the air forces of the three countries involved and the German navy. Questions of aircraft structure and life are discussed along with aspects of primary control, secondary control, the avionics systems, and the power plant in the rear. Attention is given to the command and stability augmentation system, questions of material selection, the digital computer system, problems regarding low-level flight control systems, and devices for thrust reversal which are responsible for the extraordinary short takeoff and landing capabilities of the aircraft. G.R.

A75-24130 # Aerospace technology - Planning methodology and defense-technological objectives (Luftfahrttechnologie - Planungsmethodik und wehrtechnische Zielsetzung). H. Ambos (Bundesministerium der Verteidigung, Bonn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-67*. 30 p. In German.

Questions of defense planning related to aerospace technology in the case of the department of defense of West Germany are considered, taking into account methodology and objectives on the basis of general relations. The stages involved in planning for objectives of defense technology are considered along with financial considerations and aspects of future aerospace technology. Specific defense-related investigations are concerned with novel developments, the improvement of conventional concepts, advances in fiber technology, questions of aircraft and missile control, and the development of basic physical theory related to aircraft design questions. G.R.

A75-24131 Development trends in aircraft design (Entwicklungstendenzen im Flugzeugbau). W. Herbst (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-68*. 20 p. 6 refs. In German. (MBB-UFE-1105)

The situation in the area of military aircraft is examined. Developments in fighter technology are mainly related to the improvement of thrust-engine weight relationships, a reduction in weight and increased stiffness due to an employment of composite materials, and better steady-flight performance characteristics obtained by artificial flight-path stabilization. The military advantages of an improvement of aircraft quality are evaluated. Advances in commercial aircraft design are discussed, giving attention to difficulties regarding the application of new technologies because of development cost considerations. An evaluation is also conducted of the advantages of an employment of remotely piloted vehicles. G.R.

A75-24133 # Control, stabilization, and guidance of flight vehicles (Steuern, Stabilisieren und Führen von Fluggeräten). R. Staufenbiel (Vereinigte Flugtechnische Werke - Fokker GmbH, Bremen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-75*. 47 p. 26 refs. In German.

The present work surveys the status and current trends in the development of systems for guidance, control, and stabilization of flight vehicles. The basic characteristics and design concepts of modern systems are investigated, without going into technological details concerning components or into the various control algorithms. Reliability, failure behavior, and questions of weight and serviceability are considered. Emphasis is placed on the role of digital technology in modern systems, examining aspects of monitoring and coupling of controllers and computers with peripheral equipment such as sensors, servodrives, and displays. The advantages of centralization of computational functions for guidance, control, and stabilization are examined. P.T.H.

A75-24134 # The design of flight control devices with the aid of modern system theory (Auslegung von Flugreglern mit Hilfe moderner Systemtheorie). G. Schänzer (Bodenseewerk Gerätetechnik GmbH, Überlingen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-77*. 23 p. 16 refs. In German.

The concept for a new flight control system was developed for the exacting requirements of noise-abatement flight profiles under bad weather conditions. The new system was tested in flight experiments involving automatic landing and a curved flight profile. The example of the new concept is used as a basis to discuss problems which have to be solved in an application of modern system theory. Questions of the economic implementation of flight control requirements are investigated and attention is given to problems concerning the finding of a suitable compromise between various requirements of sometimes contradictory characteristics. G.R.

A75-24135 The devising of control systems with the help of computer-aided design and their application (Entwurf von Regelungssystemen mit Hilfe von Computer Aided Design und ihre Anwendung). G. Oesterhelt and W. Kubbat (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-78*. 51 p. In German. (MBB-GD-8-74)

A computer-aided graphic-interactive method for the synthesis of multiparameter control systems is presented. The center of the man-machine process considered is a graphic-interactive display screen which is connected to the computer. Attention is given to questions of interactive design procedure selection, aspects of parameter optimization, the compressed optical results indication, and the solution of documentation problems. Implemented procedures are examined and simulation possibilities are illustrated. Examples for theoretical studies include investigations related to the Boeing 707, the Concorde, and the F 104 Starfighter. G.R.

A75-24136 # A controller of variable structure for the reduction of the complexity of flight control systems (Regler variabler Struktur zur Reduzierung der Komplexität von Flugregelungssystemen). H.-H. von Salzen (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-79*. 33 p. 8 refs. In German.

The controller considered makes use of a nonlinear procedure. The approach appears to provide solutions for a number of problems of flight control technology. The principles of operation of the controller are discussed along with the switching conditions, questions regarding an extension of the described approach to multiparameter control systems, and the application of the controller in flight control processes. The results obtained with the new controller are compared with the performance of a conventional controller, taking into account aspects of parameter sensitivity. G.R.

A75-24137 Design of a guided flight vehicle according to viewpoints of probability theory, taking into account perturbation and control parameters (Auslegung eines Lenkflugkörpers nach wahrscheinlichkeitstheoretischen Gesichtspunkten unter der Berücksichtigung von Stör- und Führungsgrößen). W. Wiemer (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-80*. 39 p. 10 refs. In German. (MBB-UA-222-74)

It is shown that with the aid of a modification equations of Bellman and Kalman can be brought into a form which makes it possible to include specific control and perturbation parameters in the optimization process, provided the parameters can be approximated by a polynomial. The derived approach requires an estimation of state variables. The estimate can be obtained with the aid of reduced observers described by Luenberger (1971), giving

attention to perturbations and parameter fluctuations. A description is given of an approach for the design of a nonlinear noise-adaptive filter for the guidance of a flight vehicle. G.R.

A75-24138 # Control and program technology for the implementation of digital flight control systems (Regelungs- und programmtechnische Realisierung digitaler Flugregelsysteme). U. Hartmann (Bodenseewerk Gerätetechnik GmbH, Überlingen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-81.* 30 p. 10 refs. In German.

A description is given of the general technical and economic conditions which have led to the development of digital flight control systems. Functions and design of digital flight control systems are considered along with their most essential characteristic parameters. The performance of an operational controller system is illustrated with the aid of examples, taking into account the principal objectives. Attention is given to a definition of the operational condition, the computation of the control signals, questions of data flow control, the implementation of preflight and in-flight tests, and aspects of error recognition and indication. The design of an experimental digital flight controller is discussed. The controller has been used to test the concept of a digital autopilot in a flight test.

G.R.

A75-24139 Results of the investigation regarding two three-dimensional low-level flight control systems (Ergebnisse der Untersuchung zu zwei dreidimensionalen Tiefflugführungssystemen). H. Achim (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-83.* 30 p. In German. (MBB-UFE-1106)

The characteristics of low-level flight are considered, taking into account terrain following and terrain avoidance flight procedures, the radar and sensor devices used, and evaluation criteria for the determination of flight control quality. An investigation is conducted concerning the possibility to provide sensor systems for the automatic terrain avoidance flight. Two different three-dimensional low-level flight procedures are found to have similar flight control characteristics.

G.R.

A75-24140 # Problems and implementation possibilities of a direct side force control in the case of fighters (Problematik und Realisierungsmöglichkeiten einer direkten Seitenkraftsteuerung bei Kampfflugzeugen). W. Benner and H. Wünnenberg (Dornier GmbH, Friedrichshafen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-84.* 43 p. 10 refs. In German. Bundesministerium der Verteidigung Contract No. TR-720-R-7600-42-009.

Questions concerning the generation of the forces needed for a lateral acceleration are examined, taking into account the effect of the forces on aircraft dynamics. The main problem is related to the compensation of perturbation moments. Simple control principles which can be implemented without complex control requirements will apply in the case of a suitable design of the direct side force control with regard to the control surfaces. It is, therefore, possible to obtain direct side force control in the case of ordinary fighters without stabilization devices.

G.R.

A75-24143 Problems in the integration of infrared line scanners in high-performance aircraft (Probleme bei der Integration von Infrarot-Streifenabtastern /line scanners/ in Hochleistungsflugzeugen). W. Franke (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-94.* 10 p. In German. (MBB-UFE-1107)

Infrared line scanners are used to obtain a thermal image of the area overflown by an aircraft. Problems regarding IR reconnaissance systems are related to questions of installation in the aircraft,

window design, the occurrence of vibrations, temperature limitations, electromagnetic compatibility, and the adaptation of the sensors to the characteristics of the aircraft avionics system. An optimal integration involves a suitable reduction of the performance-reducing perturbation factors considered.

G.R.

A75-24144 # Transonic wing design and its effects on flight performance (Transsonische Tragflügelgestaltung und ihre Auswirkung auf die Flugleistungen). M. Lotz (Dornier GmbH, Friedrichshafen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-97.* 53 p. 29 refs. In German.

The aerodynamic characteristics of the wings of medium to large aspect ratio considered depend significantly on the properties of the profiles. The development of transonic profiles with low drag characteristics was, therefore, the most important contribution to transonic wing design. Details of wing profile development are examined, giving attention to questions of rear loading, the use of supercritical airfoils, and computational procedures. Maneuvering flaps are considered along with strakes and approaches for improving the cross-sectional distribution. The effects of the advances in transonic aerodynamics on the design and the performance of the aircraft of the future are discussed, taking into account commercial aircraft and fighters.

G.R.

A75-24145 Transonic profile design (Transsonischer Profilentwurf). A. Eberle (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-98.* 30 p. 8 refs. In German. (MBB-UFE-1108)

Fundamental equations are considered along with problems of hodographic transformation, taking into account basic equations of gasdynamics in the velocity plane. The elliptical problem is examined, giving attention to a rheograph transformation, the imaging function, aspects of solution representation, and the numerical evaluation of the problem. A characteristics transformation and a numerical evaluation are discussed in the case of the hyperbolic problem. The transonic boundary value problem is also investigated.

G.R.

A75-24146 # Contribution to the study of supercritical profile flow (Beitrag zur Untersuchung der überkritischen Profilströmung). K. D. Klevenhusen and R. Hilbig (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-99.* 28 p. 10 refs. In German.

The computational procedures for the determination of transonic frictionless profile flow are briefly examined. It is shown that friction has a very significant effect on the profile pressure distribution of modern transonic profiles. A computational method in which the boundary layer conditions are taken into account with the aid of an iterative approach is presented, giving attention also to a few examples of specific profiles in order to illustrate the application possibilities of the method. Cases of profile flow which cannot yet be investigated by a computational method are also considered.

G.R.

A75-24147 # Development and wind tunnel investigation of three supercritical airfoil profiles for transport aircraft (Entwicklung und Windkanalprüfung von drei überkritischen Tragflügelprofilen für Verkehrsflugzeuge). E. Stanewsky (Aerodynamische Versuchsanstalt, Göttingen, West Germany) and H. Zimmer (Dornier GmbH, Friedrichshafen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-100.* 54 p. 12 refs. In German. Bundesministerium für Forschung und Technologie Contract No. LFF3-523-8891.

Attention is given to a direct-inverse approach for the computation of transonic profile flow, the design of supercritical profiles, an example of a transonic profile flow, the design of wing profiles for transport aircraft, and a wind tunnel investigation of the designed

profiles. A study is conducted of the effects of Reynolds number and transition on the flow characteristics at supercritical profiles, taking into account effects on lift and drag, on the characteristic parameters of profile flow, and on buffet boundary and drag rise boundary.

G.R. -

A75-24150 # Methods for the determination of noise protection areas in accordance with the law for protection against aircraft noise (Über die Methoden zur Ermittlung von Lärmschutzbereichen nach dem Gesetz zum Schutz gegen Fluglärm). E. Koppe (Industrieanlagen-Betriebsgesellschaft mbH, Ottobrunn, West Germany), H. Leinemann, K. Matschat, and E.-A. Müller (Max-Planck-Institut für Strömungsforschung, Göttingen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-110.* 23 p. 9 refs. In German.

The law for protection against aircraft noise was announced in West Germany on Mar. 30, 1971. The law provides for the establishment of noise protection areas in the vicinity of certain airports. The noise protection area comprises a region in which the aircraft noise level exceeds a certain value. The area is subdivided into two zones. The law contains restrictions concerning the utilization of the land in the two zones. This is to prevent the establishment of residential housing in areas which are exposed to aircraft noise. It is hoped to avoid by such measures future restrictions of airport operations which in the past have become necessary in certain cases because of the exposure of residential districts to aircraft noise. Buildings which are constructed in the protection zones have to meet certain sonic attenuation requirements. Questions related to the practical application of the law are discussed, giving attention to the determination of air traffic data and the extension of the protection zones.

G.R.

A75-24152 # RTOL and steep approach - Why (RTOL und Steilanflug - Warum). H.-J. Kornstädt (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-112.* 21 p. In German.

The employment of aircraft with RTOL characteristics makes it possible to use regional airports with short runways and to increase airport capacity by means of new shorter runways in cases in which the construction of additional CTOL runways is not feasible. Long CTOL runways could be subdivided and used according to a tandem configuration approach. Difficulties concerning an introduction of RTOL aircraft are related to problems arising in connection with the presence of both CTOL and RTOL aircraft in the main airports. An investigation is conducted regarding these problems, giving attention to approaches for solving them. Questions of aircraft noise abatement due to the use of a steeper approach angle are also considered.

G.R.

A75-24153 # A contribution to the problem of noise produced at the takeoff and landing of VTOL aircraft (Ein Beitrag zum Problem des Fluglärms bei Start und Landung von VTOL-Flugzeugen). V. Nitsche (Darmstadt, Technische Hochschule, Darmstadt, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-116.* 37 p. 8 refs. In German.

The reported investigation is concerned with the determination of the 'noise protection area' corresponding to a German law of 1971 concerned with protection against aircraft noise. Attention is given to a VTOL airport with a transport volume of 3 million passengers and 30,000 t freight. Effects of flight path parameters and engine thrust on the form and the size of the protective area are explored. Calculations are presented for jet and propeller-driven aircraft with a payload of 10 t. The effect of a selection of differing noise evaluation methods on the size of the protective area is discussed.

G.R.

A75-24154 # Development and use of types of construction employing fiber-reinforced materials (Entwicklung und Anwendungsmöglichkeit von Bauweisen aus faserverstärkten Werkstoffen). M. Flemming (Dornier GmbH, Friedrichshafen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 14-117.* 133 p. 33 refs. In German.

A report is presented of an investigation conducted jointly by a number of German aerospace firms to explore the possibility of a utilization of the new materials in aircraft. The use of structures utilizing fiber-reinforced materials involves a number of technical problems when compared to an employment of conventional structures. These problems are examined, giving attention to materials, approaches for affecting stiffness and strength, computation techniques, questions of stability and carrying capacity, design, and considerations concerning the operational life. Questions of impact bending strength are discussed along with aspects of erosion, corrosion, temperature characteristics, protection against lightning, inspection procedures, problems regarding material specifications, and the testing of materials in flying aircraft models. The costs of the new structures are compared with those of conventional structures.

G.R.

A75-24155 # Static computation of a wing model made of carbon fiber reinforced plastic /bending-torsion box/ with the aid of the method of finite elements and a comparison with experimental values (Statische Berechnung eines KFK-Flügelmodells /Beuge-Torsionskasten/ mit der Methode der finiten Elemente und Vergleich mit Versuchswerten). E. Henze, H. Schneider (Dornier GmbH, Friedrichshafen, West Germany), and T. Preuss (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Stuttgart, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-118.* 28 p. 6 refs. In German.

A description is given of the static computation of a thin wing design employing a full sandwich structure. The materials used in the wing include carbon fiber reinforced plastic, glass fiber reinforced plastic, and an aluminum honeycomb structure. Wing components are represented by anisotropic finite disk elements in the computer program used in the analysis. Differences of about 10% were found between experimental values and computed deformations and stresses. Effects of storage conditions and elasticity coefficients on the results are discussed.

G.R.

A75-24156 # The Alpha-Jet spoiler of carbon-epoxy material (Die Bremsklappe des Alpha-Jet in Carbon-Epoxy). H. Boche, H. Conen, E. Henze, and S. Roth (Dornier GmbH, Friedrichshafen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-119.* 28 p. 9 refs. In German.

The considerations for the selection of the material for the spoiler's structural elements are discussed. Carbon fiber reinforced epoxy prepregs are used in all cases in which a good utilization of the mechanical fiber characteristics is possible. In other cases, aluminum is employed. Design details for the spoiler are discussed along with questions of structure computation, dimensioning, tests with structural elements, aspects of fabrication, quality assurance, weight, and cost.

G.R.

A75-24157 # Development of the inlet ramp of a supersonic aircraft, employing a design which utilizes a fiber composite material (Entwicklung der Einlauftrappe eines Überschallflugzeuges in Faser-verbundwerkstoffbauweise). P. Garnatz (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-120.* 37 p. 8 refs. In German.

Aircraft which fly in the speed range at Mach number 2 require engine inlets for variable air flow rates. The adjustment of air flow rates is generally accomplished with the aid of flaps. In the

considered design, the second flap, called a ramp, has to be aerodynamically smooth. A number of structural solutions for the ramp involving various materials are discussed. Optimized-design considerations determined on the basis of the investigation led to the construction of an experimental ramp, employing a boron fiber reinforced plastic in a sandwich-construction type. G.R.

A75-24158 # Development of a VFW-614 spoiler in a design utilizing boron fiber reinforced plastic (Entwicklung eines VFW-614-Flugspoilers in BFK-Bauweise). H. Schnell (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-121.* 34 p. In German.

Particular attention is given to aspects of component design, taking into account questions of material selection. The technological problems concerning the fabrication of components made of boron fiber reinforced plastic are examined and the selected solutions are described. The results of strength tests conducted with vital spoiler components are discussed along with the static strength test carried out with the entire spoiler. Problems of component surface protection are also considered. G.R.

A75-24159 # The use of fiber-reinforced materials for compressor blades (Der Einsatz faserverstärkter Werkstoffe bei Verdichterschaukeln). R. Kochendörfer (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Bauweisen- und Konstruktionsforschung, Stuttgart, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 7th, Kiel, West Germany, Sept. 17-19, 1974, Paper 74-122.* 22 p. In German.

The strength and stiffness characteristics of composite materials make it potentially possible to obtain turbocompressors with higher speed, higher pressure ratios, or higher flow rates. A requirement for the development of turbocompressors of such improved characteristics is the reproducible manufacture of blades made of fiber-reinforced materials. The advances made so far with regard to an achievement of this goal are examined, giving attention to a selection of the most promising fiber-matrix combination, the technology for a manufacture of the selected blade with a boron-aluminum composite, and the determination of the mechanical properties of specimens from planar plates. G.R.

A75-24270 Low Reynolds number hypersonic nozzle flows. N. K. Mitra (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für angewandte Gasdynamik, Porz-Wahn, West Germany) and M. Fiebig (Duisburg, Gesamthochschule, Duisburg, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 23, Feb. 1975, p. 39-45. 14 refs.

High enthalpy, low Reynolds number hypersonic nozzle flows have been numerically investigated and compared with available experimental results. The slender channel approximations of the Navier-Stokes and energy equations have been used to describe the flow field. The numerical method developed by Rae has been modified and used for the flow field computation. Solutions have been obtained for various experimental conditions for argon and nitrogen flows. Pitot pressure, mass flow rate, total enthalpy, velocity, static temperature and Mach number profiles have been calculated. Comparisons with experimental results at the nozzle exit show in general good agreement. Discrepancies can be traced to missing measured wall temperature distributions, uncertainties in wall accommodation coefficients and assumed models for reduction of experimental data. It is concluded that the slender channel method will give reliable results for nozzle calculations where the viscous layer thickness becomes comparable with the nozzle exit radius. (Author)

A75-24271 Optimization of wind tunnel nozzles for the subsonic range (Optimierung von Windkanaldüsen für den Unterschallbereich). G.-G. Börger. *Zeitschrift für Flugwissenschaften*, vol. 23, Feb. 1975, p. 45-50. 7 refs. In German.

A calculation procedure for flow in axisymmetric and two-dimensional ducts of arbitrary contour shape is used to determine theoretically the optimum contour shape of wind-tunnel nozzles for the subsonic range. Those nozzles are considered to be best, which exhibit minimum length of construction for a given contraction ratio and for a given uniformity of the velocity distribution at the nozzle exit by avoiding boundary layer separation within the nozzle. (Author)

A75-24274 # Laboratory evaluation of the stability of high-purity jet fuels of the T-8 type and of the effectiveness of antioxidants (Laboratornaia otsenka stabil'nosti glubokookishchennogo reaktivnogo topliva tipa T-8 i effektivnosti antiokislitelei). B. A. Englin, V. M. Slitikova, R. R. Aliev, and V. V. Sashevskii (Vsesoiuznyi Nauchno-Issledovatel'skii Institut po Pererabotke Nefti i Gaza i Polucheniiu Iskusstvennogo Zhidkogo Topliva, Moscow, USSR). *Khimiia i Tekhnologiya Topliv i Masel*, no. 2, 1975, p. 40-43. 13 refs. In Russian.

A75-24341 # Forecasting traffic in an air transport network. G. N. Currie, R. W. Dickey (Bureau of Management Consulting, Ottawa, Canada), R. Duclos (Ministry of Transport, Ottawa, Canada), and W. L. Price (Ottawa, University, Ottawa, Canada). *Operations Research Society of America and Institute of Management Sciences, Joint National Meeting, 46th, San Juan, P.R., Oct. 16-18, 1974, Paper.* 22 p. 10 refs.

The problem of forecasting scheduled passenger traffic together with the corresponding scheduled aircraft movements is treated. A model is described, which starting from a forecast of origin-destination demand between city pairs for a given year, derives the station activity forecast for the same year. It thus handles the problem of routing passengers through the air transportation network. The results are expressed in terms of weekly volumes. The basic idea of augmenting the experience and skill of a human analyst with appropriate interactive programs is used in one of the modules of the model. It is concluded that partial enumeration of feasible paths between origin-destination pairs and optimization of passenger assignment over these paths is required if problems of practical size are to be approached. S.J.M.

A75-24345 Fly-by-wire delta-canard configurations save weight. W. E. Caddell (General Dynamics Corp., Convair Div., San Diego, Calif.). *Society of Allied Weight Engineers, Annual Southwestern Regional Meeting, 1st, Apple Valley, Calif., Oct. 11, 1974, Paper SWR 3.* 9 p.

The advantages offered by the canard as a primary pitch control device can now be achieved through the use of a fly-by-wire control system. An in-depth study of these advantages has shown the following sequential events reduce weight substantially, while improving fatigue life of the aircraft. Fly-by-wire permits flight with negative stability margins that permit optimum location of wing/cg/canard. Optimization of this relationship reduces the load to be carried by the wing, which reduces the required wing area and/or span. Body loads are reduced both by the removal of the down tail load on the aft fuselage and by the relieving load of the canard on the forward fuselage. Even more significant advantages accrue from the aerodynamic benefits of improved lift curve slopes, high lift coefficients without dependence upon complex and heavy high-lift devices on the wing, etc. (Author)

A75-24346 Trends in aerospace vehicle design. J. E. Ashton (General Dynamics Corp., Convair Div., San Diego, Calif.). *Society of Allied Weight Engineers, Annual Southwestern Regional Meeting, 1st, Apple Valley, Calif., Oct. 11, 1974, Paper SWR 4.* 4 p.

Ways to reduce the cost of aerospace vehicles are discussed. It is suggested that capital-intensive, rather than labor-intensive, vehicle designs and manufacturing methods be utilized. Use of composite materials and automated processes to bring down labor costs is stressed. F.G.M.

A75-24348 Method of balancing VTOL aircraft. K. Sanders (U.S. Naval Weapons Center, Advanced Aircraft Systems Program Office, China Lake, Calif.). *Society of Allied Weight Engineers, Annual Southwestern Regional Meeting, 1st, Apple Valley, Calif., Oct. 11, 1974, Paper SWR 7.33* p. 18 refs.

Some aspects of balancing VTOL aircraft in the conceptual design phase, and the attendant effects of particular VTOL concepts on the airframe aerodynamic configuration, are exposed. Cases for which only a desired CG location in percent MAC is specified usually result in two simultaneous linear equations, for engine and wing location respectively. However, in cases where the CG is expressed implicitly in terms of longitudinal stability and horizontal tail size parameters, two simultaneous nonlinear equations are usually obtained. The proposed analysis method is illustrated by five examples belonging to the 'lift/cruise' VTOL concept, for which typical linear-type equations have been derived. Fourteen basic VTOL concepts are tabulated and schematically depicted, for each of which the appropriate set of balance equations may be derived. S.J.M.

A75-24380 Hot corrosion in gas turbines. J. Stringer (Liverpool, University, Liverpool, England). In: *Corrosion problems in energy conversion and generation; Proceedings of the Symposium, New York, N.Y., October 15-17, 1974*. Princeton, N.J., Electrochemical Society, Inc., 1974, p. 79-101. 53 refs.

Hot corrosion is an accelerated oxidation of nickel, cobalt, and iron-base alloys which occurs in combustion systems in the presence of small amounts of impurities, notably sodium, sulphur, chlorine and vanadium. In most cases the attack seems to involve the condensation of a molten salt on the metal surface, and it is probable that removal of an initially protective oxide layer, either by fluxing by the molten salt or fracturing is important. The practical situation, the effect of alloy composition and of environment, testing techniques, and the current mechanistic theories will be reviewed.

(Author)

A75-24395 # The FOF wind tunnel. H. W. Baynton. *Atmospheric Technology*, Winter 1974-1975, p. 100-104.

The wind tunnel developed for performing instrument calibration tests is described. Specifications and the four speed control modes (continuous, discrete, ramp, and on/off) are presented. The discrete mode is used for routine anemometer calibrations; the ramp mode, for determining anemometer threshold response and for comparing different anemometers; and the on/off mode, for testing the response of mechanical anemometers. Determination of cross-tunnel profiles and investigation of the turbulence spectrum along the axis of the tunnel are described. It was found that the tunnel flow is laminar and subject to some relatively long-wave fluctuations, possibly related to the return flow in a furnished room or to other causes. F.G.M.

A75-24418 Generalized aerodynamic noise equation. A. L. Chandraker and M. L. Munjal (Indian Institute of Science, Bangalore, India). *Physics of Fluids*, vol. 18; Feb. 1975, p. 264, 265.

An exact aerodynamic noise equation is formulated for Newtonian fluids. The cause-effect problem is discussed. Finally, the importance of external additions of mass, momentum, and energy is examined. (Author)

A75-24481 # Practical applications of acoustic emission. H. L. Dunegan (Dunegan/Endevco, San Juan Capistrano, Calif.). In: *Acoustic emission: Application in the investigation, testing and surveillance of metallic materials; Symposium, Munich, West Germany, April 18, 19, 1974, Reports*. Oberursel, West Germany, Deutsche Gesellschaft für Metallkunde, 1974, p. 270-291. 26 refs.

Questions of pressure vessel monitoring are investigated. The one common feature of all approaches is the measurement of the time of arrival of an acoustic emission signal to a multiple array of transducers located on a structure. From the time difference

observed between individual sensors computations can be made of the location of the defect. Possibilities regarding aircraft monitoring are considered. There is overwhelming evidence that fatigue crack initiation and growth in aircraft materials can be detected under high background noise conditions. An approach for burn rate monitoring is also discussed. G.R.

A75-24481 The structure and dynamics of vortex filaments. S. E. Widnall (MIT, Cambridge, Mass.). In: *Annual review of fluid mechanics. Volume 7*. Palo Alto, Calif., Annual Reviews, Inc., 1975, p. 141-165. 66 refs. Contract No. F44620-69-C-0090.

The present work reviews some of the main results of studies in the fluid mechanics of trailing vortices and vortex rings created by aircraft wake turbulence. Attention is focused on the problem of the structure, motion, and stability of free vortices: compact regions of concentrated vorticity in free motion in a surrounding fluid that is either homogeneous and at rest or with a weak background vorticity or stratification. P.T.H.

A75-24754 Decision-making model for ATC system improvement. J. C. Yu (Utah, University, Salt Lake City, Utah) and A. G. Ulusoy (Virginia Polytechnic Institute and State University, Blacksburg, Va.). In: *Modeling and simulation. Volume 5 - Proceedings of the Fifth Annual Pittsburgh Conference, Pittsburgh, Pa., April 24-26, 1974. Part 2*. Pittsburgh, Pa., Instrument Society of America, 1974, p. 747-751. 8 refs. NSF Grant No. GK-30325.

A decision-making scheme is devised for choosing the best alternative or combination of alternatives for improving the air traffic control system at airports. The objectives of the analysis are to minimize implementation costs and social disruption, decrease delays, increase the system capacity and safety margin, and maintain acceptable noise pollution levels. All measures of effectiveness, except cost, are nondimensionalized, and a weighting scheme is used to differentiate among the relative importance of the objectives. The decision theory and analysis technique are outlined, and it is noted that the scheme is intended for use by local airport authorities, the FAA, commercial and general aircraft operators, the airport-using public, and the community where the airport is located. F.G.M.

A75-24756 Simulation - An aid to aircraft maintenance management. B. T. O'Donald (Eastern Airlines, Inc., Miami, Fla.). In: *Modeling and simulation. Volume 5 - Proceedings of the Fifth Annual Pittsburgh Conference, Pittsburgh, Pa., April 24-26, 1974. Part 2*. Pittsburgh, Pa., Instrument Society of America, 1974, p. 813-818.

A composite simulation model, consisting of assembly environment analysis, feedback control, and defect flow analysis, is constructed for effective defect evaluation and control through identification and quantification of defects, their source, and appropriate remedial action. Three segments are used in the model: defining management control parameters and assembly environments as a series of regions where mechanical defects may be introduced; adopting elements of feedback control theory to develop interactive relationships among the environments, control parameters, and defect sources; and employing a defect filter to identify and quantify the environments, parameters, and sources. The three segments are discussed, and the dimension analysis is outlined. It is noted that analysis with this model can reduce failure related events, their high costs, and the amount of resources expended in repeated repairs of assemblies whose failure can be prevented. F.G.M.

A75-24758 Modern control - Modeling and application in real aircraft flight control system design. G. L. Neal (Collins Radio Co., Cedar Rapids, Iowa). In: *Modeling and simulation. Volume 5 - Proceedings of the Fifth Annual Pittsburgh Conference, Pittsburgh,*

Pa., April 24-26, 1974. Part 2. Pittsburgh, Pa., Instrument Society of America, 1974, p. 947-950.

The application of classical and modern modeling techniques to the design of optimal control systems is discussed. Using an aircraft longitudinal tracking example, it is shown that techniques which ignore or minimize factors such as vertical gust disturbance cannot achieve optimal designs. The example is analyzed from the viewpoint of classical design theory and optimal control setup. The necessity of considering all real factors, such as disturbances, real motion, and nonlinearities in control equipment, in design modeling is stressed.

F.G.M.

A75-24802 1974 report to the aerospace profession; Proceedings of the Eighteenth Symposium, Beverly Hills, Calif., September 25-28, 1974. Symposium sponsored by the Society of Experimental Test Pilots. *Society of Experimental Test Pilots, Technical Review*, vol. 12, no. 2, 1974, 263 p.

Current and past flight test activities are considered, taking into account a flight research program to develop airborne systems for improved terminal area operations, the Concorde inlet system and peripheral envelope flight testing, and recent wake turbulence flight test programs. The spin test of AJ37 Viggen is discussed along with an F-14A assessment of operational capabilities, the lightweight fighter program, the space program after Apollo, and the test pilot and the quality control system. Attention is also given to reports related to manned space flight activities.

G.R.

A75-24803 * A flight research program to develop airborne systems for improved terminal area operations. J. P. Reeder (NASA, Langley Research Center, Hampton, Va.). (*Society of Experimental Test Pilots, Symposium, 18th, Beverly Hills, Calif., Sept. 25-28, 1974.*) *Society of Experimental Test Pilots, Technical Review*, vol. 12, no. 2, 1974, p. 1-27.

The research program considered is concerned with the solution of operational problems for the approximate time period from 1980 to 2000. The problems are related to safety, weather effects, congestion, energy conservation, noise, atmospheric pollution, and the loss in productivity caused by delays, diversions, and schedule stretchouts. The terminal configured vehicle (TCV) program is to develop advanced flight-control capability. The various aspects of the TCV program are discussed, giving attention to avionics equipment, the piloted simulator, terminal-area environment simulation, the Wallops research facility, flight procedures, displays and human factors, flight activities, and questions of vortex-wake reduction and tracking.

G.R.

A75-24804 Concorde inlet system and peripheral envelope flight testing. J. Cochrane (British Aircraft Corp., Ltd., Weybridge, Surrey, England). (*Society of Experimental Test Pilots, Symposium, 18th, Beverly Hills, Calif., Sept. 25-28, 1974.*) *Society of Experimental Test Pilots, Technical Review*, vol. 12, no. 2, 1974, p. 28-51.

The inlet system considered comprises basically two hydraulically actuated ramps moveable in the vertical plane over approximately the same range. The requirements for the design, the operation, and certification of the air intake control system (AICS) are examined, taking into account aspects of efficiency, compatibility, and tolerance. The significance of the peripheral envelope and its relevance to the flight testing of the air intake system are discussed along with the flight test program and the flight test results. Attention is given to AICS control laws and the final certification phase of flight tests.

G.R.

A75-24805 * Recent wake turbulence flight test programs. J. J. Tymczynsyn (FAA, Washington, D.C.) and M. R. Barber (NASA, Flight Research Center, Edwards, Calif.). (*Society of Experimental Test Pilots, Symposium, 18th, Beverly Hills, Calif., Sept. 25-28, 1974.*) *Society of Experimental Test Pilots, Technical Review*, vol. 12, no. 2, 1974, p. 52-68. 11 refs.

In early flight tests the size and intensity of the wake vortexes generated by aircraft ranging in size from the Learjet to the C-5A and the B-747 were studied to determine the effects of aircraft configuration, weight, and speed. Early problems were related to vortex marking, the measurement of separation distance, and test techniques. Recent tests conducted with B-747 showed that vortexes were alleviated by reducing the deflection of the outboard flaps. It was found that a more rapid dissipation of the vortex system can be obtained through alterations in the span lift distribution.

G.R.

A75-24806 F-15 update report. C. P. Garrison (McDonnell Douglas Corp., St. Louis, Mo.). (*Society of Experimental Test Pilots, Symposium, 18th, Beverly Hills, Calif., Sept. 25-28, 1974.*) *Society of Experimental Test Pilots, Technical Review*, vol. 12, no. 2, 1974, p. 71-77.

Questions of Category I testing of the aircraft are discussed, taking into account airframe major static testing and fatigue testing, flutter testing, the evaluation of handling qualities, the spin program, missile testing, and the evaluation of the F-100 engine. Aspects of design stability are investigated, giving attention to changes in the production aircraft made in response to the observation of deficiencies in the test vehicle.

G.R.

A75-24807 Report on spin test of AJ37 Viggen. K.-E. Henriksson (SAAB-Scania AB, Linköping, Sweden). (*Society of Experimental Test Pilots, Symposium, 18th, Beverly Hills, Calif., Sept. 25-28, 1974.*) *Society of Experimental Test Pilots, Technical Review*, vol. 12, no. 2, 1974, p. 79-112.

The Viggen spin test program is to demonstrate that the aircraft has the capability to recover from erect and inverted spin. The various phases of the spin program are discussed along with the special equipment used for the spin test. The spin flight test program included the investigation of the aircraft characteristics in erect and inverted stall and spin and the determination of suitable methods to recover from uncontrolled flight before entering super stall or spin.

G.R.

A75-24808 YF-16 flight test program - Lightweight fighter program. P. F. Oestricher and N. R. Anderson (General Dynamics Corp., St. Louis, Mo.). (*Society of Experimental Test Pilots, Symposium, 18th, Beverly Hills, Calif., Sept. 25-28, 1974.*) *Society of Experimental Test Pilots, Technical Review*, vol. 12, no. 2, 1974, p. 118-130.

The YF-16 has a span of 30 feet and a length of 46-1/2 feet. Details of aircraft design are discussed, taking into account the conventional aluminum construction used, the one piece windshield and canopy, the forebody strakes, and the fly-by-wire control system. The YF-16 flight test objectives include a demonstration of the fighter's design and performance goals, a demonstration of the versatility and usefulness of the aircraft in the primary combat arena, and a review of the fighting potential of the full envelope aircraft.

G.R.

A75-24809 YF-17 flight test program - Lightweight fighter program. H. E. Chouteau (Northrop Corp., Los Angeles, Calif.). (*Society of Experimental Test Pilots, Symposium, 18th, Beverly Hills, Calif., Sept. 25-28, 1974.*) *Society of Experimental Test Pilots, Technical Review*, vol. 12, no. 2, 1974, p. 131-144.

The primary objectives of the considered program include a determination of the feasibility and utility of a lightweight fighter aircraft. Critical test objectives are related to energy-maneuverability, high angle of attack characteristics, and target tracking performance. Aircraft design features are discussed along with aspects of preflight testing, and details regarding the flight test. A maximum Mach number exceeding 1.9 has been achieved in the tests.

G.R.

A75-24828 # Precision casting of aircraft and turbocompressor parts by the method of melted out models (Odlawanie precyzyjne czesci lotniczych i turbosprzerek metoda wytapianych

modeli). S. Harpula and W. Gilarski (Wytwornia Sprzetu Komunikacyjnego-Delta, Rzeszow, Poland). *Technika Lotnicza i Astronautyczna*, vol. 30, Feb. 1975, p. 29-34, 40. In Polish.

A method of obtaining highly precise castings with the aid of wax models is described. In this method, a wax model of the desired part is made that can be fashioned to a high degree of precision. This model is then used to make a ceramic form in which the final product is cast. The quality of some typical examples obtained by the method is discussed. The economic advantages of the process are also considered. P.T.H.

A75-24833 # Approximate solution to the wing theory equation by the Bubnov-Galerkin method (Priblizhennoe reshenie uravneniya teorii kryla metodom Bubnova-Galerkina). T. V. Gabedova. In: Collection of works on the equations of mathematical physics. 4. Tiflis, Izdatel'stvo Metsniereba, 1974, p. 52-56. 7 refs. In Russian.

A75-24835 # Approximate solution of integral equations with a singular operator (K priblizhennomu reshenniu integral'nykh uravnenii s singular'nym operatorom). A. V. Dzishkariani. In: Collection of works on the equations of mathematical physics. 4. Tiflis, Izdatel'stvo Metsniereba, 1974, p. 67-71. 7 refs. In Russian.

The solution of the wing equation in aerodynamics by the method of least squares is demonstrated. In addition, the procedure of solving a singular integral equation of a certain type by the Galerkin-Petrov method is outlined. V.P.

A75-24839 Manual control system design using a dual suboptimal control model. K. W. Anderson (Department of Supply, Aeronautical Research Laboratories, Melbourne, Australia) and G. F. Shannon (Queensland, University, St. Lucia, Australia). *IEEE Transactions on Systems, Man, and Cybernetics*, vol. SMC-5, Mar. 1975, p. 245-252. 18 refs.

In choosing the best parameters for compensation networks for systems including the human operator, the problem of nonconstant human operator parameters is encountered. In particular, some operator parameters vary in an adaptive way with plant dynamics. A satisfactory design must predict the operator's parameters for a particular system. A new technique regards the pilot as an optimal controller in one sense and the compensator as an optimal controller in another sense. The combination of man, machine, and compensator may then be represented by a dual optimization problem. To account for restricted numbers of variable parameters and unavailable states, the problem is modeled as a dual suboptimal (limited state feedback), control problem. Analytic expressions are obtained for the necessary conditions (dual) optimality. An algorithm based on the method of successive approximations is described. This provides for rapid solution to the optimization problem. The method by which any considered design configuration can be analyzed to rapidly establish its potential with respect to (1) designers cost and (2) pilots work load is illustrated, and results are included. (Author)

A75-24918 A finite element approach to the aeroelastic analysis of lifting surface type structures. S. S. Rao (Indian Institute of Technology, Kanpur, India). In: International Symposium on Discrete Methods in Engineering, Segrate, Milan, Italy, September 19, 20, 1974, Proceedings. Milan, Etas Libri S.p.A., 1974, p. 512, 514-525. 7 refs.

The application of the finite element method to the solution of static and dynamic aeroelasticity problems is presented. The approach is quite general and is applicable to any lifting surface type structure with arbitrary configuration, which might have cutouts and other structural discontinuities. By using the natural mode shapes as the generalized coordinates, the necessary matrix equations are derived from Lagrange's equations. The aerodynamic matrices are

obtained from piston theory and also from a quasi-steady form of a theory for two-dimensional steady flow. Numerical examples are presented to illustrate the application of the method in the solution of load distribution and flutter problems. (Author)

A75-24942 Aerodynamics of the propellers of rapidly convertible VTOL aircraft (Aérodynamique des rotors de convertibles rapides). R. Hirsch. *L'Aéronautique et l'Astronautique*, no. 50, 1975, p. 17-26. In French.

A mathematical analysis is given that permits defining propeller blade shapes which optimize efficiency for each of the two operational functions (VTOL and high-speed horizontal flight). Some experimental results are presented which demonstrate the limitations of the model. It is concluded that VTOL aircraft can be built having the horizontal speed performance and efficiency of STOL planes presently under development. S.J.M.

A75-24943 Recent progress in experimental studies of afterbodies (Progrès récents dans les études expérimentales d'arrière-corps). B. Mechin (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (Association Aéronautique et Astronautique de France, Colloque d'Aérodynamique Appliquée, 11th, Bordeaux, France, Nov. 6-8, 1974.) *L'Aéronautique et l'Astronautique*, no. 50, 1975, p. 27-33. 7 refs. In French.

An afterbody test rig in use for several years is described, and recent improvements in it are mentioned. A tangential boundary layer blowing device permits a better simulation of the flow around an afterbody. A comparison of different results obtained on a standard afterbody in various wind tunnels is presented. A new test rig project is discussed that is particularly adapted to afterbodies of high bypass ratio engines. S.J.M.

A75-24945 Design of low-pollution burners (Conception des foyers à faible taux de pollution). A. Quillévé, R. Briançon (Centre de Documentation de l'Armement, Paris, France), and J. Decoufflet (SNECMA, Moissy-Cramayel, Seine-et-Marne, France). *L'Aéronautique et l'Astronautique*, no. 50, 1975, p. 40-56. 13 refs. In French.

A review of present combustion technology and of the mechanisms of pollutant formation and evolution in and from combustion chambers is given. The pollution levels produced by engines without afterburners and by engines with partial afterburning used on the Olympus are analyzed. A mathematical model of the external combustion process is described. Procedures for reducing pollutant emission from the afterburner and especially from the main chamber are indicated, based either on improvement of classical techniques or on the use of advanced methods. Notable progress is reported in the case of incomplete combustion products produced at idling (CO and hydrocarbons) by systematically using the ring-shaped chamber, and in the case of visible fumes by employing improved partial premixing injection techniques. It is emphasized that much research is needed in the area of new methods. S.J.M.

A75-24946 Developmental programs for small expendable turbojets (Programmes de mise au point de petits turboéjecteurs non récupérables). A. Bodemer (Centre de Documentation de l'Armement, Paris, France). *L'Aéronautique et l'Astronautique*, no. 50, 1975, p. 62-65. In French.

The SETE (supersonic expendable turbine engine) program is described. Various inexpensive engines developed by different companies during separate phases of the program are diagrammed and explained. Some of the performance data on these turbojets is presented. The units appear to have been successful in attaining their objectives. Other expendable jet projects are mentioned. S.J.M.

A75-25006 # Experimentally verified analytical techniques for predicting vehicle crash response. G. Wittlin and M. A. Gamon (Lockheed-California Co., Burbank, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 11th, Washington, D.C., Feb. 24-26, 1975, Paper 75-273.* 15 p. 9 refs. Grants No. DAAJ02-71-C-0066; No. DAAJ02-73-C-0051.

Primary emphasis in the paper is on practical engineering approaches to modeling vehicle and substructure response by using simplified mathematical representations as a viable means of determining crashworthiness capability. The development of simplified analytical methods to determine nonlinear load-deflection characteristics of typical crushable integrated sheet metal/stringer type structures is described, and the analytical results are verified with experimental data from a wide variety of representative substructures under static and dynamic loading conditions. A unique finite-element-type approach is presented for the analytical prediction of complex vehicle-structure crash response. In essence, large segments of complex monocoque and/or semimonocoque structural systems are modeled as an assemblage of beam-type elements with concentrated masses. In view of the large-segment modeling representations, the classical inelastic constitutive approaches are not appropriate and instead a unique stiffness-reduction-factor technique is employed to account for large deformations, buckling, and yielded nonlinearities associated with crashing vehicles. The analytical results have been correlated with experiment using a fully instrumented helicopter under controlled crash test conditions having multi-axial crash forces.

(Author)

A75-25007 * # NASA general aviation technology programs. R. L. Winblade (NASA, General Aviation Technology Office, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 11th, Washington, D.C., Feb. 24-26, 1975, Paper 75-290.* 7 p.

This paper describes the status of the current NASA programs that are aimed at providing new technology for aircraft designs that will improve both safety and utility while reducing the environmental impact of general aviation to acceptable levels. Safety related areas that are discussed include the full scale crash test program and the stall/spin research effort. Among the programs addressing increased utility and performance, advanced airfoil developments and engine cooling drag reduction are discussed. Noise and emission reduction is a subject that is receiving significant emphasis within the NASA programs. Also included is a description of the current status of the hydrogen injection concept as a means of both lowering emissions and increasing fuel economy.

(Author)

A75-25008 # Technology for improved safety. D. A. Tuck (FAA, Flight Test Branch, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 11th, Washington, D.C., Feb. 24-26, 1975, Paper 75-291.* 3 p.

The FAA is involved in a number of research projects to develop new technology which will be useful in improving general aviation safety. We are conducting in-house projects, joint projects with other agencies, and monitoring research activities of others to advance our technology base for safety. Flight and full motion simulators are being used to study airplane performance, handling qualities, and stall prevention. Flood damaged airframes are being used to study general aviation crashworthiness in instrumented crash rigs at NASA Langley. Crashworthiness and stall prevention advances offer the greatest promise of safety improvements in general aviation. Stall/spin accidents account for a much too large percentage of the general aviation accidents and must be improved.

(Author)

A75-25012 * # The shape of the future long-haul transport airplane. C. W. Clay and A. Sigalla (Boeing Commercial Airplane Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 11th, Washington, D.C., Feb. 24-26, 1975, Paper 75-305.* 11 p. NASA-supported research.

Long-haul transport plane configurations are discussed that are considered technically feasible within a practical level of near-term technology. Supersonic and transonic aircraft are considered, as well

as different types of subsonic transports. It is indicated that superior second-generation supersonic transports are quite feasible technically; in particular, it is shown that problems of fuel consumption, efficient overland flight, and questions on noise and nitric oxides have straightforward engineering solutions. Transonic aircraft are practical but would have to have a different geometry than subsonic aircraft to provide the versatility necessary to compete at one end of their capability with supersonic transports and at the other end, for shorter ranges, with subsonic transports. The shape of subsonic transports is not expected to change noticeably, although recent advances of airfoil technology imply that new subsonic transports would have wings with higher aspect ratios and somewhat less sweep. But large specialized freighter aircraft and very long range laminar flow control or nuclear-powered aircraft with radically new shapes are possible.

S.J.M.

A75-25014 # Recent advances in the technology of aircraft noise control. R. E. Pendley (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 11th, Washington, D.C., Feb. 24-26, 1975, Paper 75-317.* 16 p. 27 refs.

Continuing research and development programs dealing with the technology of aircraft noise control have yielded recent significant advances. Certain noise sources about which little was known previously have become better understood. Concepts leading to more efficient noise suppression have been defined. This paper surveys recent results from a number of research and development programs active within industry and government. The paper discusses advances relating to the prediction and suppression of noise generated by engine components (fans, compressors, turbines, combustors, and jets). In addition, it discusses recent advances in the understanding of the noise generated by the aerodynamic flow over airframe components.

(Author)

A75-25016 # Recent advances in exhaust systems for jet noise suppression of high speed aircraft. C. D. Simcox, R. S. Armstrong, and J. Atvars (Boeing Commercial Airplane Co., Renton, Wash.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 11th, Washington, D.C., Feb. 24-26, 1975, Paper 75-333.* 10 p. 8 refs. U.S. Department of Transportation Contract No. FAWA-2893.

The present work summarizes the type of activities that have been conducted in the past few years in the area of suppression of high-speed aircraft noise and presents the results of a program relating the processes of nozzle aerodynamics, noise generation and noise transmission to jet wake flow fields, the flow fields in turn relating to nozzle system geometry. Data from a recent jet noise suppressor demonstrator is applied to the US/SST B2707-300 airplane in order to evaluate the impact of current technology. It is shown that the suppressor is a viable nozzle system that would allow the noise levels of the SST to meet FAR Part 36 requirements.

S.J.M.

A75-25051 Survival and Flight Equipment Association, Annual Conference and Trade Exhibit, 12th, Las Vegas, Nev., September 8-12, 1974, Proceedings. Canoga Park, Calif., Survival and Flight Equipment Association, 1975. 156 p. \$10.00.

Various programs and projects investigating the effects of new safety equipment and some general danger parameters in aircraft environments are reported. Topics treated include: a fluidic ejection seat control system, a crashworthy armored helicopter crew seat, anatomical displacements in temporoparietal head impacts, U.S. Navy development of helmet-compatible eyeglasses, physiological effects of long-time sitting, aircraft accident investigation for life support officers, an electrostatic vertical sensing and control concept for aircraft escape systems, commercial airline cabin attendant operational problems, and the development and operational evaluation of the CSU-15/P anti-G coverall.

S.J.M.

A75-25052 **Fluidic ejection seat control system.** C. C. Woodward (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.). In: Survival and Flight Equipment Association, Annual Conference and Trade Exhibit, 12th, Las Vegas, Nev., September 8-12, 1974, Proceedings. Canoga Park, Calif., Survival and Flight Equipment Association, 1975, p. 3-6.

A fluidic control system to stabilize an ejection seat in the pitch axis during rocket motor burn has been designed, fabricated and flight-demonstrated. It offers benefits of simplicity, higher reliability, and better maintainability over conventional electromechanical moving-part approaches. It uses freon 113 as the working medium and consists of a vortex rate sensor, a proportional amplifier, and four bistable amplifiers. Control moment is produced by the technique of liquid secondary injection thrust vector control of the rocket motor, which changes the direction of the rocket motor exhaust vector. The secondary injection ports are driven directly from the last bistable power amplifier. On the zero-altitude, zero-air-speed ejection test, it completely stabilized a two-degree equivalent c.g./rocket motor thrust line pitch offset. It is projected that this design concept can be reduced to less than 15 lbs total weight and provide up to + or -6 deg equivalent control, which should stabilize an ejection seat through 450 KIAS with proper system biasing. S.J.M.

A75-25053 **Vertical seeking ejection seat.** G. Hildebrand and E. Fessenden (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.). In: Survival and Flight Equipment Association, Annual Conference and Trade Exhibit, 12th, Las Vegas, Nev., September 8-12, 1974, Proceedings.

Canoga Park, Calif., Survival and Flight Equipment Association, 1975, p. 7-10.

Results of the first phase of an analytical study of physiological stresses imposed on a crewman being ejected by a positive-vertical-seeking ejection seat, i.e. the definition of accelerations and loads placed on him are discussed. The seat will be propelled by a two-axis gimbal rocket motor mounted in the seat bucket bottom along with a pitch actuator and a roll actuator. Calculations were made on a computer. A realistic range of flip times was established for the cases when the aircraft (especially a VTOL vehicle) was not horizontal. The effects of varying the control equation of the gimbal drive were determined. The influence on a given system of varying the thrust level was investigated. The effects of sitting height and man/seat weight changes were studied. Anatomical tolerance tests remain to be run before the present data can be applied as design criteria. S.J.M.

A75-25054 **Navy Aircrew Escape Propulsion System Program.** J. P. Kirkpatrick (U.S. Naval Air Systems Command, Propulsion Div., Washington, D.C.). In: Survival and Flight Equipment Association, Annual Conference and Trade Exhibit, 12th, Las Vegas, Nev., September 8-12, 1974, Proceedings. Canoga Park, Calif., Survival and Flight Equipment Association, 1975, p. 11-14.

Command management, program management, reliability life, and logistics/inventory are reviewed for the Navy aircrew escape propulsion system (AEPS). Aircraft support costs were reduced; a greater degree of cooperation and understanding was achieved between the AEPS logistics manager at Indian Head and cognizant personnel in fleet commands; and incorrect information in aircraft log books concerning unit life expiration dates was corrected and procedures for correct entry reemphasized, helping to reduce the number of incidents in which aircraft with overaged units installed continue flying. S.J.M.

A75-25055 **A crashworthy armored helicopter crew seat.** M. Schulman (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.) and D. Sabo (U.S. Army, Aviation Systems Command, St. Louis, Mo.). In: Survival and Flight Equipment Association, Annual Conference and Trade Exhibit, 12th, Las Vegas, Nev., September 8-12, 1974, Proceedings. Canoga Park, Calif., Survival and Flight Equipment Association, 1975, p. 15-18. 5 refs.

A crashworthy armored pilot/copilot seat has been developed that uses a system of energy attenuators to dissipate crash energy. It has been thoroughly tested under crash conditions. Installation into a test bed aircraft and flight testing have been completed. Progress is under way to retrofit the system into two helicopter series. It has also been selected as the seating system for the model 214A helicopter. Design philosophy and testing results are discussed.

S.J.M.

A75-25061 **Factors in the design of solid oxygen systems for aircraft.** W. S. McBride and T. L. Thompson (Life Support, Inc., Melbourne, Fla.). In: Survival and Flight Equipment Association, Annual Conference and Trade Exhibit, 12th, Las Vegas, Nev., September 8-12, 1974, Proceedings. Canoga Park, Calif., Survival and Flight Equipment Association, 1975, p. 58-62. 8 refs.

Components, canister design, activation system design, and problems inherent in oxygen generators functioning by the decomposition of sodium chlorate are discussed. Catalytic and pyrotechnic oxygen generation are considered, activated hypergolically with a drop of water or chemically with iron powder, respectively. The dangers of burn-through of the canister wall and remedies to them are reviewed. Various basic reaction chemistries for the two types of candles are tabulated, and the relative advantages and disadvantages of pyrotechnic and catalytic generation are enumerated. S.J.M.

A75-25067 **Ejection seat steering and control.** W. J. Stone (U.S. Naval Weapons Center, China Lake, Calif.). In: Survival and Flight Equipment Association, Annual Conference and Trade Exhibit, 12th, Las Vegas, Nev., September 8-12, 1974, Proceedings.

Canoga Park, Calif., Survival and Flight Equipment Association, 1975, p. 90-92.

An open seat ejection system is not sufficiently aerodynamically stable to overcome the pitching moments caused by tip-off and thrust/C.G. misalignment. Additionally, at high speeds, aerodynamic pitching moments can be quite large. A series of feasibility demonstration tests were conducted using thrust vector control to stabilize the seat in pitch attitude with large thrust/C.G. misalignment. The initial effort used a liquid secondary injection system. A second concept used a gimbal motor to achieve larger TVC (thrust vector control) angles. It is believed that seat steering can be extended to include two-axis control (three-axis if required) and the capability to fly an upward trajectory after ejecting from an inverted aircraft. (Author)

A75-25068 **Electrostatic vertical sensing and control concept for aircraft escape systems.** V. D. Burklund (U.S. Naval Weapons Center, China Lake, Calif.). In: Survival and Flight Equipment Association, Annual Conference and Trade Exhibit, 12th, Las Vegas, Nev., September 8-12, 1974, Proceedings.

Canoga Park, Calif., Survival and Flight Equipment Association, 1975, p. 93, 94.

A general discussion about the use of the earth's electrostatic field as an autopilot attitude reference is presented. The basic electrostatic principles, proposed system configuration, expected performance, work completed to date, possible limitations, and future work planned at the Naval Weapons Center are considered. The information would be used primarily to keep the aircraft vertical when it was necessary for the pilot to eject. S.J.M.

A75-25069 **Emergency and disaster plans, and associated problems concerning major aircraft accidents.** J. T. Childs (National Transportation Safety Board, Washington, D.C.). In: Survival and Flight Equipment Association, Annual Conference and Trade Exhibit, 12th, Las Vegas, Nev., September 8-12, 1974, Proceedings. Canoga Park, Calif., Survival and Flight Equipment Association, 1975, p. 98-103.

Potential emergencies resulting from the crash of a wide-bodied jet and disaster plans developed for emergencies of such magnitude are discussed. The basic functions of the National Transportation

Safety Board and implementation of a disaster plan (including crowd control, fire and rescue operations, on-scene medical aid and evacuation, and wreckage investigation and handling) are outlined. A review of disaster programs in the Washington, D.C., metropolitan area conducted by the Safety Board is described, and two aircraft accidents involving problems of recovery and rescue operations in a remote area and near a metropolitan airport are detailed. The development of airport-based emergency facilities is considered.

F.G.M.

A75-25070 Pilot control/display factors for helicopters /PIFAX-H/. D. D. Sams and E. G. Webb, Jr. (USAF, Instrument Flight Center, Randolph AFB, Tex.). In: Survival and Flight Equipment Association, Annual Conference and Trade Exhibit, 12th, Las Vegas, Nev., September 8-12, 1974, Proceedings.

Canoga Park, Calif., Survival and Flight Equipment Association, 1975, p. 109-113. 6 refs.

A three-phase program for pilot control/display factors of helicopters is developed to investigate the full instrument potential of the helicopter and then improve the instrument flight capabilities within the helicopter operational mission environment. The study of Phase I baseline flying revealed the capabilities and deficiencies within the standard helicopter control-display system. The baseline study helped establish an initial configuration of refined controls and displays. Phase II is being conducted to evaluate individually each feature of the new controls and displays with the aim of reducing pilot workload and enhance performance efficiency.

S.D.

A75-25098 * # Multilevel control optimization using sub-system relative performance index sensitivity. G. G. Leininger (Toledo, University, Toledo, Ohio) and F. B. Lehtinen (NASA, Lewis Research Center, Cleveland, Ohio). In: Symposium on Multivariable Technological Systems, 3rd, Manchester, England, September 16-19, 1974, Preprints.

London, Institute of Measurement and Control, 1974, p. S24-1 to S24-3.

A method is presented for the design of optimal feedback controllers for large multivariable systems with subsystem sensitivity constraints. The weighted sum of subsystem and/or operational mode relative performance index sensitivities is defined as the overall performance index. The method is developed for linear systems with quadratic performance criteria and either full or partial state feedback. An example concerning the design of a stability augmentation system for a VTOL aircraft in the transition mode demonstrates the effectiveness of the design method.

(Author)

A75-25120 Review of integral-equation techniques for solving potential-flow problems with emphasis on the surface-source method. J. L. Hess (Douglas Aircraft Co., Theoretical Aerodynamics Section, Long Beach, Calif.). *Computer Methods in Applied Mechanics and Engineering*, vol. 5, Mar. 1975, p. 145-196. 66 refs.

The problem of interest is that of incompressible potential flow about two- and three-dimensional bodies. Formulation of this problem as an integral equation over the body surface is an especially efficient procedure because the solution can be calculated on the body surface without considering the remainder of the flow field. The various possible integral equations that can be derived to represent the solution are discussed. Principal emphasis is on techniques of solution. The integral equation is replaced by a set of linear algebraic equations. The numerical problems are those associated with efficient calculation of the relevant 'influence' matrices and with the solution of the resulting equations, whose coefficient matrix is nonsymmetric and full. Certain useful approximations are outlined, and direct and iterative matrix techniques are compared and evaluated. The problems and techniques associated with the lifting flows are discussed in some detail. Alternate approaches pursued by other investigators are described. Sample calculations are presented, and some of them are compared with experiment to illustrate the remarkable agreement of potential flow and real flow.

(Author)

A75-25125 Breaking with tradition. R. J. Pearson (Central London, Polytechnic, London, England). *Flight International*, vol. 108, Mar. 13, 1975, p. 409-412.

The present article examines the limitations of traditional measures of airline efficiency and suggests ways in which they may be improved. The conventional input measure, total number of employees, is tabulated as the domain variable of various output measures - km flown, departures, passenger-km performed, tonne-km performed, and available tonne-km. A similar table is provided with input measured in dollars of labor costs, and its advantages are pointed out. A table of productivity of individual labor categories, such as maintenance and overhaul personnel, flight-crew personnel, cabin attendants, and all other personnel, are given, and a reciprocal table of labor group costs per output unit is presented. Various productivity graphs are drawn, and a good inverse linear correlation is found between aircraft hours/\$1000 input of maintenance and overhaul personnel and maintenance and overhaul expenses/aircraft hour.

S.J.M.

A75-25180 Aeroelasticity of plates and shells. E. H. Dowell (Princeton University, Princeton, N.J.). Leiden, Noordhoff International Publishing, 1975. 151 p. 102 refs. \$19.

Basic physical relations related to the aeroelasticity of plates and shells are described. Linear and nonlinear theoretical aeroelastic models are considered along with aspects of aerodynamic theory. Attention is given to potential flow aerodynamics, shear flow aerodynamics, angle of flow effects, and cavity acoustics. An investigation is conducted of the structural response to turbulent boundary layer pressure fluctuations. The correlation of theory and experiment is discussed, taking into account nondimensional similarity parameters and scaling, flutter results for particular structural geometries and loading conditions, and postflutter behavior and structural response to turbulent boundary layer pressure fluctuations.

G.R.

A75-25181 Stability theory and its applications to structural mechanics. C. L. Dym (Bolt Beranek and Newman, Inc., Waltham, Mass.). Leiden, Noordhoff International Publishing (Mechanics of Elastic Stability, No. 3), 1974. 199 p. 101 refs. \$16.

Aspects of geometric theory are examined, taking into account definitions of stability, equilibrium phase plane analysis, and general phase plane analysis. Questions of autonomous system stability are discussed along with stability concepts for continuous systems, results from nonlinear elasticity theory, and buckling and post-buckling of elastic columns, elastic plates, and circular arches. Applications of Liapunov functionals are also considered, giving attention to the wave equation, a hydrodynamics problem, linear anisotropic elasticity, an aeroelastic problem, the instability of an Euler column, and a bounding example.

G.R.

A75-25185 A model for rain erosion of homogeneous materials. G. S. Springer and C. B. Baxi (Michigan, University, Ann Arbor, Mich.). In: Erosion, wear, and interfaces with corrosion; Proceedings of the Symposium, Philadelphia, Pa., June 24-29, 1973. Philadelphia, Pa., American Society for Testing and Materials, 1974, p. 106-124; Discussion, p. 125-127. 40 refs. Contract No. F33615-71-C-1572.

In this report the behavior of homogeneous materials subjected to repeated impingements of liquid droplets was investigated. Based on fatigue theorems, a model was presented for describing both the incubation period $n_{sub i}$ (that is, the time elapsed before the mass loss of the material becomes appreciable), and the mass loss past the incubation period m . The parameters were established which govern the length of the incubation period and the subsequent mass loss rate, and simple algebraic expressions were developed relating $n_{sub i}$ and m to the properties of the impinging droplets and the material. The limits of applicability of the model was also established. The results obtained were compared to available experimental data. Reasonable agreement was found between the present results and the data, indicating that the model developed can be used to estimate the incubation period and the mass loss of the material.

(Author)

A75-25188 Influence of velocity, impingement angle, heating, and aerodynamic shock layers on erosion of materials at velocities of 5500 ft per s /1700 m per s/. G. F. Schmitt, Jr. (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio), W. G. Reinecke, and G. D. Waldman. In: Erosion, wear, and interfaces with corrosion; Proceedings of the Symposium, Philadelphia, Pa., June 24-29, 1973. Philadelphia, Pa., American Society for Testing and Materials, 1974, p. 219-238. 6 refs.

The dependence of materials erosion in rain at supersonic velocities up to 1700 m/s (5500 ft/s) has been determined as a function of velocity, impingement angle, and aerodynamic heating. The erosion rate of materials has been found to vary with the 4.5 to 6.5 power angle. Coupled heating and erosion effects are highly significant for polymeric composites. The effects of shock layer breakup, acceleration, deflection, and deformation of the droplets have been quantitatively assessed, and damage gradients in materials are shown to be a function of primarily droplet distortion and breakup resulting from drop traversal of the shock layer around the vehicle. (Author)

A75-25189 Effects of fatigue and dynamic recovery on rain erosion. A. F. Conn and S. L. Rudy (Hydronautics, Inc., Laurel, Md.). In: Erosion, wear, and interfaces with corrosion; Proceedings of the Symposium, Philadelphia, Pa., June 24-29, 1973.

Philadelphia, Pa., American Society for Testing and Materials, 1974, p. 239-260; Discussion, p. 261-269. 28 refs. Contracts No. N00019-70-C-0276; No. N00019-71-C-0297.

The latest results from a study of the dynamic behavior of rain erosion-resistant coating and substrate materials are described. The correlations between rocket sled erosion data and fracture stresses determined from single-impact tests with a split Hopkinson pressure bar facility have been extended to include polyurethane. The results of tests within a small-scale erosion facility, and analyses of large whirling-arm studies, have shown that a fatigue type of behavior, already found to be applicable for an acrylic plastic, may also be used to describe the rain erosion resistance of elastomeric coatings such as polyurethane, and the glass fiber-reinforced epoxy composite substrates which are frequently utilized for radome construction. The importance of the 'dynamic recovery rate' or relaxation time, and stress wave interactions, in understanding the rain erosion phenomenon is described in this paper. The applicability of the elastic-plastic, uniaxial stress wave theory for making rain erosion predictions is also discussed. (Author)

A75-25212 An iterative improvement for finite element analysis. C. W. Martin (Nebraska, University, Lincoln, Neb.). In: Finite element methods in engineering; Proceedings of the International Conference, Kensington, Australia, August 28-30, 1974.

Kensington, Australia, Unisearch, Ltd., 1974, p. 213-217. 8 refs.

An iterative improvement procedure is proposed for automatic detection and avoidance of truncation errors which occur in the assembly of the system stiffness matrix, particularly, in the dangerous situations where errors (of 50 to 60 percent) exist that are large enough to cause structural failure, but not large enough to be really obvious. The procedure involves extended precision calculations with the element stiffness matrices to provide a measure of error in computed displacements due to truncation. Furthermore, the process yields more accurate values of displacements when it converges. V.P.

A75-25229 Foreign object impact damage to composites; Proceedings of the Symposium, Philadelphia, Pa., September 20, 1973. Symposium sponsored by the American Society for Testing and Materials. Philadelphia, Pa., American Society for Testing and Materials (ASTM Special Technical Publication, No. 568), 1975. 250 p. \$22.75.

Papers are presented which report on analyses of the response of composite materials, structures, and structural components to impact of various kinds. Some of the topics covered include comparison of

ballistic impact response of metals and composites for military aircraft applications, impact damage tolerance of graphite-epoxy sandwich panels, residual strength characterization of laminated composites subjected to impact loading, failure mechanisms in composite plates impacted by blunt-ended penetrators, and studies of impact structural damage of composite blades.

P.T.H.

A75-25230 Comparisons of the ballistic impact response of metals and composites for military aircraft applications. J. G. Avery and T. R. Porter (Boeing Aerospace Co., Seattle, Wash.). In: Foreign object impact damage to composites; Proceedings of the Symposium, Philadelphia, Pa., September 20, 1973.

Philadelphia, Pa., American Society for Testing and Materials, 1975, p. 3-29. 12 refs.

A side-by-side comparison was made of the available residual strength and damage size test data for metals and fiber composites damaged by small arms projectiles. In addition, the available composite data was used to extend a model for predicting the ultimate strength of composite tension panels damaged by bullets. This model was used in conjunction with an existing model for metals to extend the comparisons to equal strength, equal stiffness, or equal weight structural panels. The results show that both metal and fiber composite panels lose a significant per cent of their undamaged strength (50 per cent or more) when impacted with small arms projectiles. For the cases considered, the per cent reduction in the fiber composite panels was greater than in the metal panels. These results are considered to be preliminary for structural evaluations, however, because only simple panel data were used in the comparison. (Author)

A75-25232 * Impact response of graphite-epoxy flat laminates using projectiles that simulate aircraft engine encounters. J. L. Preston, Jr. and T. S. Cook (United Aircraft Corp., Pratt and Whitney Aircraft Div., Middletown, Conn.). In: Foreign object impact damage to composites; Proceedings of the Symposium, Philadelphia, Pa., September 20, 1973.

Philadelphia, Pa., American Society for Testing and Materials, 1975, p. 49-71. 5 refs. Contract No. NAS3-15568.

An investigation of the response of a graphite-epoxy material to foreign object impact was made by impacting spherical projectiles of gelatin, ice, and steel normally on flat panels. The observed damage was classified as transverse (stress wave delamination and cracking), penetrative, or structural (gross failure): the minimum, or threshold, velocity to cause each class of damage was established as a function of projectile characteristics. Steel projectiles had the lowest transverse damage threshold, followed by gelatin and ice. Making use of the threshold velocities and assuming that the normal component of velocity produces the damage in nonnormal impacts, a set of impact angles and velocities was established for each projectile material which would result in damage to composite fan blades. Analysis of the operating parameters of a typical turbine fan blade shows that small steel projectiles are most likely to cause delamination and penetration damage to unprotected graphite-epoxy composite fan blades. (Author)

A75-25240 Studies on the impact structural damage of composite blades. C. T. Sun and R. L. Sierakowski. In: Foreign object impact damage to composites; Proceedings of the Symposium, Philadelphia, Pa., September 20, 1973.

Philadelphia, Pa., American Society for Testing and Materials, 1975, p. 212-227. 9 refs.

The dynamic response of jet engine fan blades subjected to foreign object impact loadings has been investigated. Two analytical methods based upon a discrete mass distribution have been used for model purposes. Numerical results for blade natural frequencies, tip displacements, and bending moments have been obtained for boron-aluminum, graphite-epoxy, titanium, and stainless steel blades. Numerical data have been discussed for the various materials considered. (Author)

A75-25274 # Engine failure prediction techniques. R. C. Hunter. *Aircraft Engineering*, vol. 47, Mar. 1975, p. 4-6, 8-14.

The present work is primarily concerned with early failure detection, by optical examination, of metal particles emanating from oil-wetted components in aircraft gas turbine propulsion systems. It also includes a brief summary of in-flight engine health monitoring and boroscope inspection currently employed and under development, for application to the new generation of Rolls-Royce RB211 engines in the Lockheed Tristar L-1011 airliner. S.J.M.

A75-25275 # Fuelling systems. T. E. Ford. *Aircraft Engineering*, vol. 47, Mar. 1975, p. 16-18.

Hydrant installations are discussed. The advantages of these systems over mobile fuellers are briefly presented, and concomitant problems with the former are considered, such as maintaining pressures in the aircraft tanks and contaminant control. Fuel dispenser vehicles required for hydrant systems are described. S.J.M.

A75-25342 Fire-fighting in airport premises. L. Scheichl. *Airport Forum*, vol. 5, Feb. 1975, p. 31, 32, 35 (4 ff.). In English and German.

Airport systems and facilities constituting potential fire hazards are listed in a table together with the preferential fire-extinguishing methods to be used. A description of extinguishing methods is given, taking into account the extinguishing mechanisms involved, their field of application, their specific advantages, and their drawbacks. Attention is given to the foam extinguishing method, the dry powder extinguishing method, the combined powder/foam extinguishing method, the high-expansion foam method, the water extinguishing method, the carbon dioxide extinguishing method, and the halocarbon extinguishing method. G.R.

A75-25343 Mobile lounge or fixed gate. H.-H. Kuckuck (Deutsche Lufthansa AG, Hamburg, West Germany). *Airport Forum*, vol. 5, Feb. 1975, p. 47-54. In English and German.

An analysis is conducted of the relative advantages and drawbacks in the case of the fixed gate and the mobile lounge concept. The functional characteristics of the two concepts are examined. It is pointed out that the reduction in walking distances possible by the employment of the mobile lounge could also be achieved by a new terminal design. Economic aspects are also discussed, giving attention to investment planning, personnel requirements, and operating costs. G.R.

A75-25458 The diffraction of a shock wave by a slender body. K. Morgan (Exeter, University, Exeter, Devon, England). *Zeitschrift für angewandte Mathematik und Physik*, vol. 26, Jan. 25, 1975, p. 13-29. 7 refs.

The problem of the interaction of a plane normal shock wave of arbitrary strength with a general slender body is treated by the method of matched asymptotic expansions. An inner solution valid near the body, an outer solution valid away from the body together with an inner-shock solution valid in the region which is both near the body and near the shock are required. It is shown how the pressure near the body can be obtained if the solution for steady flow past the same body is known, and the lateral forces acting on the body can be determined by using the result of Ward (1949). The general results are applied to the problem of diffraction by a circular cone, and the presence of the inner-shock solution is shown to contribute a term to the expression for the drag coefficient. (Author)

A75-25459 The subsonic-supersonic analogy (Zur Unterschall-Überschall-Analogie). E. Leiter (Wien, Technische Hochschule, Vienna, Austria). *Zeitschrift für angewandte Mathematik und Physik*, vol. 26, Jan. 25, 1975, p. 31-41. 18 refs. In German.

Concepts of source and source-like singularity are considered together with Hadamard's theory of integration, giving attention to

an extensive analogy of integral solutions for the thickness problem in the case of supersonic and subsonic flow. An investigation is conducted of aspects of disturbed analogy. Nonsingular individual solutions are discussed, taking into account the Volterra theory of integration and the derivation of the integral equation of the lifting surface according to an approach which is based on the solution of the Dirichlet boundary value problem for the upper half-space. G.R.

A75-25697 SLAR, its principles of operation and requirements regarding the positional stability of carrier platforms (Seitensichtradar, sein Arbeitsprinzip und Anforderungen an die Lagestabilität von Trägerplattformen). Mr. Fogy (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Oberpfaffenhofen, West Germany). *Ortung und Navigation*, no. 4, 1974, p. 75-86. In German.

The applications of SLAR (Side-Looking-Airborne-Radar) require resolutions on the ground in the range from about 10 sq km to about 1 sq m. The employment of the principle of the synthetic aperture (SA) can be necessary in connection with requirements which are also related to the platform characteristics and the flight altitude. The principles of the SA are briefly considered, giving attention to SLAR geometry and questions of resolution. Requirements of platform position are investigated for satellites and aircraft. G.R.

A75-25713 * # NASA's role in aeronautics. J. L. Jones (NASA, Office of Aeronautics and Space Technology, Washington, D.C.). *AIAA Student Journal*, vol. 12, Oct. 1974, p. 10-12.

NASA civil aviation research efforts in regard to noise reduction, development of very quiet engines, fuel conservation, and aircraft efficiency and safety are outlined. Specific projects discussed include the supercritical wing program, the fly-by-wire control system, the modified JT8D jet engine, the two-segment noise abatement landing procedure, the general aviation safety program, the GAW-1 low speed airfoil, the Army/NASA tilt rotor flight research project, and the remotely piloted research vehicle program. F.G.M.

A75-25715 Characteristics of air bearings with small inlet holes for a precision coordinate measuring device. S. Sugimori, M. Kawaguti, and S. Yamamoto (Tokyo, University, Tokyo, Japan). *Japanese Journal of Applied Physics*, vol. 14, Feb. 1975, p. 280-287. Research sponsored by the Japan Society for the Promotion of Science.

A75-25719 # General aviation safety - Fact and fiction. M. K. Strickler (FAA, Washington, D.C.) and J. J. Eggspuehler (Ohio State University, Columbus, Ohio). *AIAA Student Journal*, vol. 12, Winter 1974-1975, p. 8-12.

General aviation accident statistics are reviewed. An overview of accidents in 1970 is provided, with the accidents placed in the four general categories of instructional, noncommercial, commercial, and miscellaneous flying. The most frequent types of accidents and causes of fatal and nonfatal accidents are listed, and it is noted that the 10 leading causal citations all involved pilot failure. The role of the Biennial Flight Review section of FAR Part 61 in accident rate reduction is assessed. F.G.M.

A75-25723 # Tests of a theoretical model of jet noise. N. S. M. Nosseir and H. S. Ribner (Toronto, University, Downsview, Ontario, Canada). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-436*. 11 p. 35 refs. Research sponsored by the General Electric Co. and National Research Council of Canada; Grant No. AF-AFOSR-70-1885.

The present study establishes the approximate invariance with frequency of a certain parameter beta formed from experimental measurements of jet noise. The parameter beta, essentially a shear noise/self noise spectral ratio, is a construct of Ribner's theory, and this invariance is predicted by the theory. The experimental data also

confirm the prediction that the shear- and self-noise spectra match in shape, and that they exhibit a relative shift of close to one octave. The theoretical model as used herein provides a simple closed-form framework for the prediction of jet noise, excluding the refraction valley. The main empirical input is the spectrum at 90 deg to the jet axis. S.J.M.

A75-25724 * # New evidence of subsonic jet noise mechanisms. S. P. Pao and L. Maestrello (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-437*. 10 p.

Measurements of sound gradient near a subsonic jet have shown that coherent sound is emanated from the flow in the form of narrow beams. Within any given short period of time, sound appears to come from small volumes in the jet with a preferred direction of propagation for that particular moment. These conclusions are drawn from a large data base using correlation techniques, and are further confirmed by additional experiments. (Author)

A75-25729 # Wake cutting by a cascade of cambered blades. C.-M. Ho and L. S. G. Kovaszny (Johns Hopkins University, Baltimore, Md.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-445*. 6 p. 9 refs. Research supported by the United Aircraft Corp.

The transient pressure distribution developed on one of the cambered blades of a cascade during the passage of an upstream wake was the subject of the experiments. In response to the periodic passage of the wakes a periodic component of the surface pressure fluctuations was created and it was extracted by periodic sampling and ensemble averaging. The most interesting result found was the significant difference in the transient pressure signatures depending on the direction of the passage of the wakes, namely, whether the suction side or the pressure side of the cambered blade was 'slapped' first by the passing oblique wake. The consequence of this large difference may be quite important to noise generation by wake cutting in rotating machines. (Author)

A75-25730 * # Noncompact source effect on the prediction of tone noise from a fan rotor. S. Kaji (NASA, Ames Research Center, Moffett Field, Calif.; Tokyo, University, Tokyo, Japan). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-446*. 13 p. 12 refs.

A comparison is made between the conventional compact source prediction for airfoil sound radiation and the rigorous prediction based on distributed sources along the airfoil chord. The theoretical analysis performed is for a single airfoil and cascaded airfoils immersed in a sinusoidally varying convected gust field. The pressure field around a single airfoil in supersonic gust flows is also studied. In subsonic flows the phase change of unsteady lift along the chord of a single airfoil reduces the sound radiation significantly in the upstream direction and increases the downstream radiation compared to the compact source prediction. In supersonic flows the compact source prediction gives substantial error in the region just behind the Mach wedge originating from the leading edge, while it approaches the noncompact source results far downstream from the airfoil. In the case of cascaded airfoils the compact source prediction overestimates the upstream radiation by as much as 20 dB depending on frequency and interblade phase. (Author)

A75-25731 # Turbine noise generation, reduction and prediction. S. B. Kazin and R. K. Matta (General Electric Co., Evendale, Ohio). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-449*. 15 p. 37 refs. U.S. Department of Transportation Contract No. FA72WA-3023.

The fundamental nature of turbine noise generation is explored both analytically and experimentally and the pertinent design parameters identified. In addition, the effect of inlet turbulence on noise generation by a high pressure turbine is examined. Also, turbine noise reduction through increased blade row spacing is demonstrated through computation and experiment. The fundamental lessons learned in preparing the calculation method and during examination of the component test data are applied to engine test data in order to facilitate the construction of an engine turbine noise prediction. The noise generated is found to be a function of the velocity and work extraction. The phenomenon of turbine tone interaction with jet stream turbulence, which results in 'haystacking' of the discrete frequency signal, is discussed. (Author)

A75-25732 # Noise of high speed rotors. D. L. Hawkings and M. V. Lowson (Westland Helicopters, Ltd., Yeovil, Somerset, England). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-450*. 12 p. 10 refs.

A theory for discrete tone open rotor noise at high subsonic and supersonic tip speeds is presented. It is based primarily on linearized flow concepts, and applies to both propeller and helicopter rotor configurations. Equal emphasis is placed on both frequency and time domain descriptions of the acoustic field. The far field acoustic pressure is related to the blade geometry, velocity and loading distributions, and the analysis shows the particular importance of these quantities near the blade tips in controlling the noise output. The theory is applied to both a supersonic propeller and a helicopter main rotor, and encouraging agreement with experimental results is obtained in both cases. (Author)

A75-25733 # Discrete frequency rotor noise. J. W. Leverton (Westland Helicopters, Ltd., Yeovil, Somerset, England). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-451*. 10 p. 9 refs. Research supported by the Ministry of Defence.

A detailed study has been made of the discrete frequency (rotational) noise characteristics of a 2 bladed 56 ft diameter rotor running 'upside-down' on a whirl tower so that the flow distortion effects were reduced to a minimum. The results show that with the exception of the higher harmonics at low tip speed, discrete frequency noise tends to be independent of thrust. This is of interest since previous theoretical/experimental studies have indicated a thrust-square law. The results also show that the discrete frequency noise increases approximately according to the sixth power of velocity, except at zero thrust when the dependency is on the eighth power of velocity. (Author)

A75-25734 # V/STOL rotor and propeller noise - Its prediction and analysis of its aural characteristics. R. P. White, Jr. (Systems Research Laboratories, Inc., Rochester, N.Y.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-452*. 10 p. 13 refs.

A purely theoretical technique of predicting rotor and propeller noise has been developed. This analysis technique has the ability to investigate the effects of the basic aerodynamic parameters of rotor powered vehicles on the acoustic signature received by an observer. This paper briefly describes (1) the basic features of the theoretical technique, (2) how it is used, and (3) demonstrates the capabilities of the technique in predicting the detailed acoustic signature of helicopter rotors in hover and during a flyby. (Author)

A75-25735 * # Thickness noise of helicopter rotors at high tip speeds. F. Farassat (NASA, Langley Research Center; George Washington University, Hampton, Va.), R. J. Pegg, and D. A. Hilton (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-453*. 7 p. 10 refs. Grant No. NGR-09-010-085.

A new formulation of helicopter rotor thickness, noise for hover and forward flight, is discussed. The parameters required for this formulation are rotor motion, planform and airfoil thickness distribution. A computer program has been developed to calculate the pressure signature due to blade thickness for a helicopter in arbitrary motion. Comparison with high-speed helicopter tests shows good agreement with calculations when the observer is in or near the horizontal plane in which the rotor disk lies. Characteristics of thickness noise are illustrated by numerical examples indicating strongly that the high-speed blade slap may be due primarily to the thickness effect. The methods of Deming and Arnoldi are discussed as the special cases of this technique. (Author)

A75-25736 * # The development of experimental techniques for the study of helicopter rotor noise. W. L. Harris and A. Lee (MIT, Cambridge, Mass.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-455*. 7 p. 6 refs. Contract No. NAS2-7684.

The acoustic characteristics of a low noise open jet wind tunnel have been obtained by employing two different calibration techniques. One technique is to measure the decay of sound pressure with distance in far field. The other technique is to utilize a calibrated speaker as a sound source. The sound pressure level vs frequency was obtained in the wind tunnel testing chamber and compared with the corresponding calibrated values. The results of two different techniques agree with each other. Fiberglass board-block units were installed on the testing chamber interior. The free field was increased significantly after this treatment and the testing chamber cut-off frequency was reduced to 160 Hz from the original designed 250 Hz. The flow field characteristics of the rotor-tunnel configuration were studied by using flow visualization techniques. (Author)

A75-25737 * # Jet noise source location by cross-correlation of far field microphone signals. S. P. Parthasarathy (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-456*. 6 p. Contract No. NAS7-100.

A theoretical analysis is presented for the evaluation of correlation functions of many spatially separated noise sources in a jet. A one-dimensional model is considered in which the noise sources are located on the axis of the jet downstream of the nozzle. The theory for extracting the spatial distribution from far field cross-correlations by signal analysis is derived. The advantage of this method is that difficult numerical inversions are not needed. (Author)

A75-25738 # Measurement and prediction of jet noise in flight. K. W. Bushell (Rolls-Royce /1971/, Ltd., Derby, England). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-461*. 10 p. 12 refs.

The most difficult problem facing the aircraft noise engineer is the determination of the level of jet mixing noise in flight. Recent measurements of a range of aircraft are compared with measurements of static engine noise. These comparisons show a reduction in noise close to the jet axis as predicted by theory and shown in wind tunnel investigations, but at 90 deg to the engine axis no reduction is observed in complete contrast to both theory and wind tunnel measurements. At forward angles, an increase in absolute noise level is often observed. The implications to jet noise prediction in flight are discussed. (Author)

A75-25739 # Simulation of flight effects on aero engine fan noise. B. W. Lowrie (Rolls-Royce /1971/, Ltd., Derby, England). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-463*. 9 p. 9 refs.

It is now widely recognized that in flight an element of aero engine fan noise, i.e., distortion tones, reduce significantly compared to static conditions. Since these tones dominate on static tests it is difficult to carry out meaningful research and development testing using ground facilities. In an effort to study and overcome this problem a number of possible solutions have been tried and are described including the effects of using intake screens, 'conditioning' the air before it is drawn into the fan intake, and using a moving vehicle. From these experiments the requirements for forward speed simulation are being derived. (Author)

A75-25740 # Effect of forward motion on fan noise. J. E. Merriman and R. C. Good (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-464*. 11 p. 19 refs.

A test program was conducted to investigate the effect of forward motion on the fan noise generated by a CF6-6 turbofan engine installed on a McDonnell Douglas DC-10-10 airplane. Acoustic measurements were made with nine microphones mounted internally in the inlet and the fan-discharge ducts, one fuselage-mounted microphone, and an array of ground microphones. The results of the test program indicated that the primary difference between static and flight data is the reduced inflight level of the fan fundamental tone for fan rotor speeds below cutoff. Under static test conditions, there is sufficient inlet flow turbulence to cause the generation of a strong blade-passage-frequency tone at approach power settings. With forward motion, however, these noise-generating mechanisms are minimized, and the level of the fan tone is reduced. This result suggests that the use of static engine noise data to design acoustically treated nacelles may result in unnecessary weight and performance penalties for the required inflight noise reductions. (Author)

A75-25741 # Model and full scale test results relating to fan noise in-flight effects. J. P. Roundhill and L. A. Schaut (Boeing Commercial Airplane Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-465*. 11 p. 8 refs.

Full scale high bypass ratio engine noise comparisons are shown that indicate fan noise in-flight is lower than would be estimated from static data extrapolations. This effect is most prevalent at subsonic fan tip speeds and is attributed to the static test inflow turbulence conditions aggravating the rotor-alone noise generation. A model scale fan test was conducted in which the fan inflow turbulence was minimized using a large screened inlet and the results compared with conventional bellmouth inlet measurements. In addition, tests were conducted with and without exit guide vanes to determine the significance of the rotor and stator sources with controlled fan inflow. Both full scale and model test results indicate that fan inflow changes from static to flight conditions significantly affect fan source noise and extrapolating normal uncontrolled static data to flight can be misleading. The results also indicate that the screened inlet approach is a promising method to better simulate in-flight fan noise in static tests. (Author)

A75-25742 # The noise behaviour of aero engine turbine tones. J. J. Fletcher and P. H. Smith (Rolls-Royce /1971/, Ltd., Derby, England). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-466*. 7 p. 11 refs. Research supported by the Ministry of Defence (Procurement Executive).

A review is made of the experiments, conducted by Rolls-Royce, on both engines and research model turbine rigs, to investigate turbine tone noise. The main purpose of the paper is to categorize the different types of turbine tones by their own individual spectral and field shape character. The relationships of these tones to turbine operating conditions are discussed and suggestions made with regard to possible source generation and propagation mechanisms. Some mention is made of 'cut-off' and its possible relevance to design studies. (Author)

A75-25743 # Measurements of static inlet turbulence. D. B. Hanson (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-467*. 11 p. 8 refs.

The structure of turbulence entering a bellmouth inlet has been assessed under conditions normally considered ideal for an outdoor static noise test of a turbofan. Turbulence with the following properties was measured when the ambient winds ranged between 0 and 4 knots: transverse component intensities up to 4.6%; stream wise component intensities roughly 1/3 the transverse values; axial length scale (product of integral time scale and mean velocity) between 20 and 60 inlet diameters; and circumferential length scales of about 1/5 the inlet diameter. This inlet flow structure, suggesting long, thin 'sausages' of turbulence, is ideal for generating noise by interaction with a rotor. (Author)

A75-25744 * # A study of subsonic fan noise sources. D. B. Hanson (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-468*. 13 p. 17 refs. Contract No. NAS1-12505.

Sources of noise in a 1.4 m (4.6 ft) diameter subsonic tip speed propulsive fan were studied using a combination of theoretical, experimental, and computer plotting techniques developed specially for noise diagnosis. To assess the structure of inlet turbulence, signals measured from pressure transducers on a rotor blade were plotted in a format to show the space-time history of inlet distortion. Ingested turbulence contained long, thin eddies which produce a tone-like noise component. Turbulence generated in the shroud boundary layer upstream of the rotor tips was found not to be an important noise source. However, this boundary layer does contain large amplitude disturbances caused by inlet turbulence which could be important in fans with thicker boundary layers. Theoretical calculations based on measured blade pressures show that rotor/inlet turbulence interaction and rotor/stator interaction are equally important sources of noise near the first three harmonics of blade passing frequency. At higher frequencies (above 2000 Hz) the rotor noise is dominant. (Author)

A75-25745 * # Scrubbing noise of externally blown flaps. M. R. Fink (United Aircraft Research Laboratories, East Hartford, Conn.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-469*. 12 p. 22 refs. Contract No. NAS3-17863.

An experimental study was conducted to examine the aero-acoustic mechanism that produces externally blown flap (EBF) scrubbing noise, i.e. a surface-radiated noise which is generally strongest normal to UTW deflected flaps. Scrubbing noise was not radiated from portions of the surface adjacent to strong, locally coherent turbulent eddies. Instead, scrubbing noise seemed to come from weak loading fluctuations that were coherent along the scrubbed span. These loading fluctuations probably were induced by the convected large-scale vortex structure of the attached exhaust jet. Deflecting a UTW flap would reduce the distance between the vortex trajectory and the flap surface, increasing the resulting dipole noise and rotating its directivity. In contrast, deflecting a USB flap would increase this distance, so that observable scrubbing noise would be radiated only from the undeflected forward portion of the wing.

S.J.M.

A75-25746 # Experimental investigation of the aeroacoustic characteristics of model slot nozzles with straight flaps. G. T. Patterson, M. C. Joshi, and J. R. Maus (Tennessee, University, Tullahoma, Tenn.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-471*. 10 p. 9 refs. U.S. Department of Transportation Contract No. FA72WA-3053.

A75-25747 * # Fluctuating pressures on aircraft wing and flap surfaces associated with powered-lift systems. J. S. Mixson, J. A. Schoenster, and C. M. Willis (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-472*. 11 p. 7 refs.

The present work presents results from two research studies that provide information on the fluctuating pressures generated by the use of powered-lift systems in STOL aircraft. Data are given for several chordwise and spanwise locations on large-scale models of an externally blown flap (EBF) configuration and an upper surface blown flap (USB) configuration in which actual jet engines were used. Pressure levels were high enough to indicate that special design effort will be required to avoid acoustic fatigue failures of wing and flap structures. The observation that pressure levels did not decrease very much with increased distance from the engine exhaust center line suggests that a STOL aircraft fuselage, which is in relatively close proximity to the engines for aerodynamic reasons, will be subjected to unusually high external overall fluctuating pressure levels (OAFPLs) that may cause difficulty in control of the cabin noise level. S.J.M.

A75-25748 * # Acoustic characteristics of a large upper-surface blown configuration with turbofan engines. J. S. Preisser and D. J. Fratello (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-473*. 9 p. 19 refs.

This paper presents acoustic results from static and simulated low forward velocity tests of a large-scale model of an aircraft configuration with two turbofan engines in the full-scale tunnel at the Langley Research Center. The turbofan engines were integrated into the model and equipped with rectangular nozzles to provide the upper-surface blowing. Results indicate that the upper-surface blowing noise problem can be characterized, primarily, by the unsymmetrical radiation pattern due mainly to shielding of the high-frequency engine noise and the production of low-frequency noise by jet-surface interaction. The directivity of the low-frequency noise was found to depend on the trailing-edge flap angle when the thrust levels were low. Normalized sound pressure level spectral density data showed good agreement at low Strouhal number with other small- and large-scale model data from tests using simulated wing-flap systems. Forward speed effects were undetectable at the low tunnel speeds used during the tests. (Author)

A75-25749 # Noise shielding effects for engine-over-wing installations. V. M. Conticelli, A. Di Blasi (Aeritalia S.p.A., Naples, Italy), and J. V. O'Keefe (Boeing Commercial Airplane Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-474*. 16 p.

Developments in noise shielding effects of engine-over-wing installations based on recent high bypass ratio full scale engine and scale model tests are presented. Both the attached and unattached installations are addressed. Engine noise components are isolated and test data are compared with theoretical analysis. Community noise reductions attributable to the engine-over-wing installations are defined for typical takeoff and landing conditions. (Author)

A75-25750 * # Forward velocity effects on under-the-wing externally blown flap noise. J. Goodykoontz, U. von Glahn, and R. Dorsch (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-476*. 14 p. 10 refs.

Noise tests were conducted with small-scale models of externally blown-flap powered-lift systems that were subjected to simulated takeoff and landing free-stream velocities by placing the nozzle-wing models in a free jet. The nozzle configurations consisted of a conical and an 8-tube mixer nozzle. The results showed that the free-stream

velocity attenuated the noise from the various configurations with the amount of attenuation depending on the flap setting. More attenuation was obtained with a flap setting of 20 deg than with a flap setting of 60 deg. The dynamic effect on the total attenuation caused by aircraft motion is also discussed. (Author)

A75-25751 # Experiments on supersonic jet noise. J. Laufer, R. Schlinder, and R. E. Kaplan (Southern California, University, Los Angeles, Calif.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-478.* 16 p. 26 refs. U.S. Department of Transportation Contract No. OS-00002.

Certain aspects of the noise generation by a supersonic jet were investigated at jet Mach numbers 15, 2.0 and 2.5. In particular, the axial source strength per unit length, w , was determined using a specially developed directional microphone system. The integrated value of w along the jet axis was found to be consistent with the sound intensity obtained by conventional direction microphone confirming the a priori assumption that the jet consists of independent, spatially compact acoustic sources. The main finding of the investigation is the presence of two distinct intense noise producing regions in a jet having supersonic source velocities, the upstream region radiating in the form of Mach waves. An estimate of the fraction of the radiated intensity associated with the Mach waves is also made. (Author)

A75-25752 # The near field sound pressures of a choked jet when oscillating in the spinning mode. R. Westley and J. H. Woolley (National Aeronautical Establishment, Ottawa, Canada). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-479.* 9 p. 10 refs.

A75-25754 * # Ambient and induced pressure fluctuations in supersonic jet flows. V. Barra, S. Slutsky, and S. Panunzio (New York University, Westbury, N.Y.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-482.* 14 p. 29 refs. Grant No. NGR-33-016-177.

An experimental investigation of the ambient static pressure fluctuations and induced acoustic fields in supersonic jet flows has been undertaken to identify possible noise sources and the mechanisms involved in the propagation of disturbances within the flows. The axisymmetric cold air jet under investigation exhausted from a 7-in. exit diameter C-D nozzle run in two conditions: one yielding a fully expanded flow and the other an overexpanded flow. The survey of static pressure fluctuations consisted of measurements of the overall levels and spectra of the fluctuations along the centerline of the two flows and the variation in level across various transverse sections. The second aspect of the study involved the development of a procedure for tracing the propagation of externally induced periodic pressure disturbances inside the jet. (Author)

A75-25755 * # Diagnostic calculations of airframe-radiated noise. R. E. Hayden, Y. Kadman, D. B. Bliss, and S. A. Africk (Bolt Beranek and Newman, Inc., Cambridge, Mass.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-485.* 13 p. 22 refs. NASA-supported research.

Methods of calculating airframe noise due to the following components are presented: wings and stabilizers, flaps, landing gear 'self-noise', landing gear bay (wheel well) oscillations, separated flow interaction with edges of cavities, and doors associated with gear deployment. The predominant source mechanisms were dipole-like in nature, being related to the local fluctuating aerodynamic forces on struts, airfoil edges, cavity edges, etc. Available data are converted into semiempirical prediction methods to enable a tentative rank ordering of noise sources. A sample application of these prediction procedures is carried out for a typical CTOL passenger jet using actual aircraft parameters, where available. S.J.M.

A75-25756 # Aircraft far-field aerodynamic noise - its measurement and prediction. G. J. Healy (Lockheed-California Co., Burbank, Calif.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-486.* 9 p. 13 refs.

The material presented in this paper is a synopsis of what is believed to be the first systematic investigation of far-field radiated, aerodynamically generated noise from 'clean' configured aircraft during low altitude unpowered flight. Five aircraft, ranging in weight from 5785 to 173,925N (1300 to 39,000 pounds) and having wing aspect ratios ranging from 6.59 to 18.25, were tested at flight velocities ranging from 30 to 98.5 m/sec (58 to 191.5 knots or 98 to 323 ft/sec). An equation relating far-field aircraft aerodynamic noise to readily evaluated physical and operational parameters of the vehicle was developed from the results of these measurements. In addition, a slight modification to this equation is herein proposed which permits accurate computation of the recently published far-field aerodynamic noise from the Lockheed Jet Star and the Convair F-106B delta wing Mach 2 aircraft. (Author)

A75-25757 # Induced drag effect on airframe noise. J. D. Revell (Lockheed-California Co., Burbank, Calif.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-487.* 18 p. 28 refs.

In a companion paper (75-539) and previous work in 1974, the author has predicted the non-engine aerodynamic noise (airframe noise) by expressing the acoustic energy as being proportional to the mechanical energy dissipated by each major drag component. Empirical constants are derived from flyover noise test data. Wing profile drag noise and wing induced drag noise are thus identified as important components at typical landing approach lift coefficients (1.3 to 1.5). This paper shows how trailing vortex wake turbulence causes extra wing pressure fluctuations. The associated force fluctuations radiate dipole noise whose strength is related to the induced drag. The theory gives explicit but approximate expressions for narrowband SPL. Numerical results are shown for one-third octave band SPL. The levels compare well with the empirically derived spectra in AIAA Paper 75-539; however, the present one-third octave spectra have a flatter shape. (Author)

A75-25758 * # Measurements of discrete vortex noise in a closed-throat wind tunnel. S. S. Davis (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-488.* 8 p. 16 refs.

Measurements are presented of the discrete vortex noise emitted by a thin airfoil. These measurements were made in a new wind tunnel designed specifically for aerodynamic noise measurements. The tunnel is an indraft type with a 25- by 35- by 100-cm testing section and a sonic-throat noise suppressor just downstream of the test section. Directivity and standing wave patterns are presented and compared with theoretical predictions. Frequency scaling criteria are developed and compared with other investigations. (Author)

A75-25759 * # Trailing edge noise. C. K. W. Tam (Florida State University, Tallahassee, Fla.) and J. C. Yu (George Washington University; NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-489.* 13 p. 16 refs. Grant No. NSG-1021.

Shadowgraphic observations of the flow structure of a wall jet downstream of the trailing edge of a flat plate were carried out. Shadowgraphs obtained at jet exit Mach number 0.3 to 0.8 consistently showed an orderly large oscillatory flow structure. It is believed that these large scale disturbances are the result of flow instabilities. It is also believed that these orderly disturbances are responsible for generating the dominant part of trailing edge noise either directly or indirectly. The interaction of sound generated by

these coherent oscillatory flow disturbances and the plate was investigated theoretically. It is found that the farfield noise directivity is strongly influenced by diffraction of sound at the leading edge of the plate. (Author)

A75-25761 # Effect of geometry on open cavity flow-induced pressure oscillations. M. E. Franke (USAF, Institute of Technology, Wright-Patterson AFB, Ohio) and D. L. Carr (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-492*. 9 p. 10 refs.

Geometric modifications for reducing flow-induced pressure oscillations in shallow, open, two-dimensional, rectangular cavities with the flow tangential to the cavity opening are investigated. Cavity length-to-depth ratios from 1 to 4 1/4 are considered. Qualitative screening of various cavity configurations is accomplished on the water table at Froude numbers ranging from 0.6 to 3.3. Configurations showing good suppression characteristics in water are further examined in an air flow apparatus by comparing narrow-bandwidth cavity pressure measurements at flow Mach numbers of approximately 1.6. Ramps at the leading and trailing edges of the rectangular cavities are found to be effective in reducing the pressure amplitudes under some conditions. (Author)

A75-25763 * # Influence of grazing flow on duct wall normal impedances. P. Mungur and J. L. Whitesides (George Washington University; NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-494*. 9 p. 13 refs. Grant No. NGR-09-010-064.

A theory is developed for evaluating the normal impedance of an orifice connecting a cylindrical cavity to a flow duct. The impedance of a piston velocity source at the orifice is calculated in terms of the cavity modes which are modified by the presence of a vortex flow. The strength of the vortex is related to the mean flow in the duct. Results are presented showing the variation of the normal impedance spectrum with the cavity vortex. The trends of these variations are confirmed by comparison with measurements. (Author)

A75-25766 * # Sound propagation in curved ducts. M. K. Myers and P. Mungur (George Washington University; NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-497*. 9 p. 6 refs.

An analysis of the sound field in a circularly curved duct of rectangular cross-section is carried out for both rigid and locally-reacting absorbing walls. The field is excited by a piston source at one end of the duct section, and comparisons of the acoustic field and the net power flow along the duct axis are made with corresponding results for a straight duct section for various frequencies. It is found that in general the curved duct yields a significant increase in sound attenuation along the duct axis as compared to the straight duct. (Author)

A75-25769 * # Minimization of jet and core noise of a turbojet engine by swirling the exhaust flow. I. R. Schwartz (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-503*. 9 p. 9 refs.

A noise abating improvement for jet engines has been investigated and demonstrated using a full scale turbojet engine which provided the means for significant reductions in jet and core noise with minimal thrust loss. This was accomplished by controlled solid body rotation (swirling) of the flow in the nozzle and jet exhaust. Relatively moderate angles of solid body rotation in the presence of temperature, density, pressure, and velocity gradients were utilized.

Of great interest was the finding that significant reductions of sound pressure levels and sound power were obtained with only a small percentage of the total primary mass flow swirling at the exit of the nozzle. Therefore, tradeoffs between noise reduction and engine performance can be optimized to satisfy aircraft performance and federal noise standards with minimal wasted rotational kinetic energy. (Author)

A75-25771 * # Cross-correlation of noise produced inside a hot turbojet exhaust with and without suppression using a new, hot probe. W. C. Meecham and D. R. Regan (California, University, Los Angeles, Calif.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-505*. 7 p. 9 refs. NASA-supported research.

The noise producing region of a hot turbojet exhaust is studied by cross-correlating hydrodynamic pressure fluctuations within the exhaust with far field sound for Mach numbers up to 0.99. Measurements are made on unsuppressed engine and on a suppressed engine fitted with a 31-tube multijet nozzle. Hydrodynamic pressure fluctuations inside the hot exhaust are measured using a special 1/4 inch diameter probe tube (acoustically damped and air cooled), fitted with a ported nose cone. Maximum, normalized cross-correlations of 0.2 are found for Ma = 0.99 at an angle of 30 deg. (Author)

A75-25772 # The effects of forward speed on a number of turbojet exhaust silencers. J. R. Brooks (Rolls-Royce /1971/, Ltd., Bristol, England) and R. J. Woodrow (Hawker Siddeley Aviation, Ltd., Hatfield, Herts., England). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-506*. 12 p.

Flight and static noise measurements have been made on eight exhaust configurations of a turbojet engine installed in an HS 125 aircraft. These configurations comprised plain and suppressor nozzles tested with and without a tailpipe acoustic lining. Static noise measurements were made on an open noise-test site and were supported by test-bed performance calibration of each configuration. It has been found that only at angles less than about 40 deg to the jet axis does the exhaust noise correlate on a basis of jet velocity relative to the atmosphere; at angles greater than about 60 deg absolute jet velocity is a better correlating parameter. In the forward arc noise increases have been observed, static-to-flight, with the conical nozzle configuration. These noise increases are greatest at high jet velocity and disappear when either a suppressor nozzle or an acoustically-lined tailpipe is used. (Author)

A75-25773 * # Noise radiation from turbulent flows over compliant surfaces. Y. S. Pan (NASA, Langley Research Center; George Washington University, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-507*. 14 p. 34 refs. Grant No. NGR-09-010-085.

The present study is based on Lighthill-Curle's theory of aerodynamic noise. Using a correlation approach and the image concept of Powell, the volume contribution of turbulent flow over a large surface is approximated by a surface contribution of pressure fluctuations. Far-field noise intensities are expressed in terms of the surface pressure fluctuations and surface impedance. Based on available experimental measurements, numerical examples are performed for noise radiated from a turbulent boundary layer and from a normal jet impingement over rigid surfaces. Comparisons with available noise measurements are made. For general turbulent flows over compliant surfaces, measurements are suggested to obtain useful data for noise predictions. (Author)

A75-25775 * # Airframe noise measurements on a transport model in a quiet flow facility. J. G. Shearin and P. J. Block (NASA, Langley Research Center, Hampton, Va.). *American Institute of*

Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-509. 6 p. 8 refs.

An experimental investigation was conducted in an anechoic flow facility to explore problems and methods of measuring the airframe (nonpropulsive) noise associated with a 1/20-scale model of a B-737 transport. The test model geometry simulated the cruise and a landing configuration. Nonpropulsive model noise was detected at various flow velocities and at various angles of attack when turbulent flow was induced over the model. Discrete tones, associated with the extended undercarriage and wheel cavities, and an increase in broadband sound pressure level were observed with the model in a landing configuration. (Author)

A75-25776 * # Measurements and analysis of aircraft airframe noise. T. W. Putnam, P. L. Lasagna (NASA, Flight Research Center, Edwards, Calif.), and K. C. White (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-510.* 8 p. 8 refs.

Flyover measurements of the airframe noise of Aero-Commander, JetStar, CV-990, and B-747 aircraft are presented. Data are shown for both cruise and landing configurations. Correlations between airframe noise and aircraft parameters are developed and presented. The landing approach airframe noise for the test aircraft was approximately 10 EPNdB below present FAA certification requirements. (Author)

A75-25777 # An experimental study of airframe self-noise. P. Fethney (Royal Aircraft Establishment, Aerodynamics Dept., Farnborough, Hants., England). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-511.* 12 p. 9 refs.

Some results are given of an investigation into the level of the airframe self-noise of four aircraft, ranging from a slender delta to a long-range transport. These aircraft, with their engines at flight idle, flew over a ground array of measuring microphones arranged to cover the noise directly beneath the flight path and on the side-line. The flight programme included a range of airspeeds and aircraft configurations. The intrinsic statistical error in the measurements was reduced by ensemble averaging the outputs of the several microphones for a number of overflights. Measurements of engine noise for the static aircraft were used to correct the flight data for the residual engine contribution. The experimental and analytical techniques are described, the measured airframe noise levels and spectra are presented and the relative contributions of some of the airframe components identified. Comparisons with empirical methods of estimation show only moderately good agreement and do not support the hypothesis that the dominant noise source is a vertically aligned dipole. (Author)

A75-25778 * # A preliminary investigation of remotely piloted vehicles for airframe noise research. D. J. Fratello and J. G. Shearin (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-512.* 7 p. 6 refs.

Aircraft noise encountered in the community is caused predominantly by the aircraft engines. However, expected advances in engine noise technology combined with recent experimental evidence indicate that airframe (nonpropulsive) noise, may be a significant aircraft noise component in the future. Thus, methods for research into control of this type of noise are being evaluated and a technique based on the remotely piloted vehicle (RPV) concept appears to overcome some of the difficulties encountered with other test techniques. In particular, this paper presents sample experimental data, gathered during a preliminary RPV experiment, which illustrate the high signal-to-noise ratio attainable with this technique. Further, since the data are recorded as transients or nonstationary signals, a method of measurement and analysis is presented which increases statistical confidence in the results. (Author)

A75-25779 # An experimental investigation of noise-shielding effects for a delta-winged aircraft in flight, wind tunnel and anechoic room. R. W. Jeffery and T. A. Holbeche (Royal Aircraft Establishment, Aerodynamics Dept., Farnborough, Hants., England). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-513.* 11 p. 10 refs.

Pronounced airframe acoustic shielding and flow-field refraction effects have been studied at both full scale and model scale on a small slender delta-winged research aircraft. The experiments at 1/4-scale using a wind tunnel model fitted with suitably scaled noise sources, tested in both an anechoic room and a large acoustic wind tunnel, have assisted interpretation of the in-flight data by enabling shielding by the wing and refraction by the vortex over its highly swept leading edge to be studied separately as components of the total noise reduction. Simple diffraction theory accounts fairly well for the measured wing shielding. Although the noise propagation sideways was complicated by the vortex refraction, the overall effect was beneficial, reducing noise significantly in the region outside the acoustic shadow of the wing. (Author)

A75-25780 * # Sparse matrix techniques applied to modal analysis of multi-section duct liners. W. R. Arnold (NASA, Langley Research Center; George Washington University, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-514.* 6 p.

A simplified procedure is presented for analysis of ducts with discretely nonuniform properties. The analysis uses basis functions as the generalized coordinates. The duct eigenfunctions are approximated by finite series of these functions. The emphasis is on solution of the resulting large sparse set of linear equations. Characteristics of sparse matrix algorithms are outlined and some criteria for application are established. Analogies with structural methods are used to illustrate variations which can increase efficiency in generating values for design optimization routines. The effects of basis function selection, number of eigenfunctions and identification and ordering of equations on the sparsity and solution stability are included. (Author)

A75-25781 * # Acoustic wave propagation in a lined duct with non-uniform admittance. J. C. Yu, C. D. Smith, and P. Mungur (NASA, Langley Research Center; George Washington University, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-515.* 9 p. 7 refs.

The problem of acoustic wave propagation in a lined duct with non-uniform liner admittance distribution has been analyzed. Two different methods of solution are discussed. Computations are made for a simple example of symmetrically lined two-dimensional duct containing a unit pressure source distribution. The non-uniform admittance variation is assumed to be a homogeneous random function along the direction of wave propagation. The influences of the spatial scale of the admittance variation, the magnitude of the variation and their dependence on mean liner admittance on sound attenuation are presented. The predicted trends agree qualitatively with existing experimental findings. (Author)

A75-25782 # Computational methods for acoustic radiation from circular ducts. R. J. Beckemeyer, D. T. Sawdy, and P. Garner (Boeing Co., Wichita, Kan.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-516.* 11 p. 24 refs. Research supported by the Boeing Commercial Airplane Co.

Radiation from circular ducts in the absence of mean flow is investigated using classical flanged and unflanged models, and an approximate spherical wave function technique. The latter method has been presented in the literature as a means of investigating jet

refraction effects, but work on duct interior to exterior coupling has not appeared. In the present paper, results obtained using the three methods are compared, computational difficulties encountered in applying the approximate technique are described, and observations are made pertinent to the problem of generalizing to the case with mean flow in light of these difficulties. (Author)

A75-25783 # Effects of a conical segment on sound radiation from a circular duct. D. T. Sawdy, R. J. Beckemeyer, and P. Garner (Boeing Co., Wichita, Kan.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-517.* 10 p. 23 refs. Research supported by the Boeing Commercial Airplane Co.

Radiation from a circular duct with a terminating conical segment in the absence of mean flow has been investigated by using a separation of variables technique. A spherical wave expansion was used to provide a multimodal representation of the acoustic field in the conical segment which was then incorporated into a multi-sectioned uniform circular duct analysis. The predicted effects of converging and diverging nozzles on the propagation of sound through a multiple sectioned duct are compared with results of an approximate stepped duct analytical technique and with experimental data. (Author)

A75-25784 * # Generalized wave envelope analysis of sound propagation in ducts with stepped noise source profiles and variable axial impedance. K. J. Baumeister (NASA, Lewis Research Center, V/STOL and Noise Div., Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-518.* 11 p. 7 refs.

A75-25786 * # The convergence of theory and experiment in direct combustion generated noise. W. C. Strahle (Georgia Institute of Technology, Atlanta, Ga.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-522.* 8 p. 18 refs. Grants No. NSG-3015; No. AF-AFOSR-72-2365.

Current theories of combustion generated noise are reviewed with regard to their ability to predict the sound power output and spectral characteristics of noise generated by several flame types. New experimental information on open turbulent flames and on gas turbine combustor cans is presented. Available information on gas phase diffusion flames is reviewed. It is concluded that if some of the gross turbulence features of the flame are known and if the acoustical behavior of any flame enclosure is known, then scaling rules for behavior of the sound power output and spectral content may be quite accurately produced by theory. On the other hand, the theory is not sufficiently advanced to make absolute predictions; such predictions must await more detailed knowledge of turbulent flame structure. (Author)

A75-25788 * # Combustion intensity and distribution relation to noise generation. E. G. Plett, M. D. Leshner, and M. Summerfield (Princeton University, Princeton, N.J.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-524.* 10 p. 17 refs. Contract No. N00014-67-A-0151-0029; Grant No. NGR-31-001-307.

Experiments with several different flame holder geometries were conducted to investigate the degree to which combustion roughness can be altered by altering the flame intensity and flame distribution in a ducted combustion system. The effect of admitting primary air through a plane-slotted or a slotted-swirl vane flame holder was compared and the combustion roughness and noise was contrasted with that obtained with a closed front-end perforated can. The slotted front-end burners produced much smoother burning and less noise than the closed front-end can. No advantage was apparent with swirl vs nonswirl when approximately the same inlet flow distribu-

tion was maintained. Preheated inlet air provided somewhat smoother combustion as compared with ambient temperature air. The combustion roughness with methyl alcohol was briefly compared with that of isooctane; indications are that it burns more smoothly, but more detailed studies are needed to substantiate these indications. (Author)

A75-25790 # An experimental investigation of the core engine noise of a turbofan engine. R. G. Hoch, P. Thomas, and E. Weiss (SNECMA, Paris, France). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-526.* 14 p. 14 refs.

An experimental investigation has been conducted on a Larzac twin spool turbofan engine in order to identify the major core engine noise sources and to assess the efficiency of some noise suppression systems. A particular modification of the engine was designed and built in order to eliminate or substantially reduce the inlet and exhaust radiated fan noise and the core and fan jet noise. This modification includes inlet and fan exhaust suppressors, both provided with throttling devices. The core engine jet velocity and associated jet noise are substantially reduced by increasing the nozzle area, while maintaining the nominal engine operating schedule by appropriate throttling of the inlet and fan exhaust flows. Engine arrangements, test procedures and typical results are described. (Author)

A75-25791 # Core engine noise due to temperature fluctuations convecting through turbine blade rows. G. F. Pickett (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-528.* 13 p. 8 refs.

A75-25792 # Outdoor jet noise facility, a unique approach. R. A. Kantola (GE Research and Development Center, Schenectady, N.Y.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-530.* 12 p. 8 refs. U.S. Department of Transportation Contract No. OS-30034.

The new acoustic jet noise facility used at the General Electric Corporate Research and Development Center (CR&D) that minimizes outdoor-related drawbacks is described. Acoustic purity and calibration test results are presented, indicating spherical divergence, ground reflection corrections, effects of microphone boom and support structure, facility noise, jet noise calibrations of the facility, overall sound power level, one-third octave power and pressure spectra, and directivity. Axial noise source location measurements of cold round subsonic jets using the 'hole-in-the-wall' technique are reported as an example of the use of the facility. The outdoor apparatus minimizes ground reflections and has a very short turn-around time and a high data acquisition rate so that testing within short periods of favorable weather is possible. The unique features of the equipment have not impeded its ability to obtain high-quality jet noise measurements on both cold and heated jets. S.J.M.

A75-25798 * # Development of a new computer system for aircraft noise prediction. J. P. Raney (NASA, Langley Research Center, Aircraft Noise Prediction Office, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-536.* 5 p. 5 refs.

The paper presents an overview of the activities of NASA's Aircraft Noise Prediction Office (ANOPO). The principal goal of ANOPO is to develop a comprehensive, user-oriented, Aircraft Noise Prediction Program (ANOPP). ANOPO's activities in support of ANOPP development are briefly discussed. They include acquisition, implementation, and evaluation of an in-house, interim collection of programs and implementation of a plan for acquiring, in the form of Key Technology Documents, state-of-the-art methodology for air-

craft noise prediction. The paper is primarily devoted to a presentation of the general architecture and functional capability planned for ANOPP together with the rationale supporting major design decisions. (Author)

A75-25799 # Aircraft flyover noise measurements. E. L. Zwieback (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-537.* 8 p. 18 refs.

The current work describes, in general terms, present equipment and techniques utilized to make complete precision (comprehensive) measurements of the flyover noise of jet transport aircraft. Differences in measurement equipment and techniques, depending on the objectives and type of airplane involved, are indicated; limitations resulting from a variety of technical uncertainties and practical problems are discussed. Problem areas include noise sources, noise propagation, noise recording, and data processing. Some research plans to reduce the impact of the measurement limitations are suggested. S.J.M.

A75-25800 # Review of theory and methods for the prediction of ground effects on aircraft noise propagation. P. B. Oncley (MAN-Acoustics and Noise, Inc., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-538.* 7 p. 23 refs.

A75-25801 # Methods for the prediction of airframe aerodynamic noise. J. D. Revell, G. J. Healy (Lockheed-California Co., Burbank, Calif.), and J. S. Gibson (Lockheed-Georgia Co., Marietta, Ga.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-539.* 16 p. 30 refs.

There are three basic methodologies for the prediction of airframe (non-engine) aerodynamic noise: (1) the whole aircraft method; (2) the aircraft drag element method and (3) the individual component distributed source method. A brief review of all three methodologies is presented with prediction methods covering the first two categories detailed. The whole aircraft method is based entirely on measured airframe noise whereas the aircraft drag element method is formulated from knowledge of the drag coefficients of the major airframe noise contributors with a number of constants evaluated from measured airframe data. (Author)

A75-25802 # Review of theory and methods for turbine noise prediction. D. C. Mathews, R. T. Nagel, and J. D. Kester (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-540.* 11 p. 22 refs.

The state-of-the-art of turbine noise prediction is reviewed. A literature survey was conducted and current methods for turbine noise prediction are discussed and compared. The technology required for advanced prediction methods is discussed; including generation of noise by turbine blade and vane elements, propagation and attenuation of the noise through blade rows, and noise radiation through the turbulent jet to the far field. Research areas are suggested that are critical to the future improvement of turbine noise prediction methods. (Author)

A75-25803 # Review of theory and methods for combustion noise prediction. R. E. Motsinger and J. J. Emmerling (General Electric Co., Cincinnati, Ohio). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-541.* 9 p. 32 refs. U.S. Department of Transportation Contract No. FA72WA-3023.

The state-of-the-art theory of engine combustion noise is reviewed. The results of a literature survey are summarized, and formulas for the prediction of combustion noise are presented. A compilation of necessary empirical data is given, and the accuracy and range of validity of these data are indicated. These formulas and data include effects of noise generation by the combustion process, scaling laws for spectral content, acoustic power and thermo-acoustic efficiency. Methods of predicting engine combustion noise generation are recommended. Research which is critical to the improvement of combustion noise prediction is identified. (Author)

A75-25804 * # Propagation of aircraft noise over long distances through the lower atmosphere. A. L. Abrahamson (Wyle Laboratories, Inc., Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-542.* 7 p. 25 refs. Army-NASA-supported research.

Propagation of sound through the lower atmosphere is influenced by numerous factors which are difficult to measure and more difficult to predict. In addition to the well known laboratory observable loss mechanisms of heat conduction, gas transport, and molecular absorption, inhomogeneities in a real atmosphere have significant influence on a propagating sound wave. This study presents a qualitative discussion of different categories of atmospheric inhomogeneity and their individual and combined effects on sound propagation. Subsequently, a field test involving the propagation of aircraft noise over distances up to 10 miles is described, and a simplified empirical model for 'excess' atmospheric attenuation due to inhomogeneities in the atmosphere is derived from the data. (Author)

A75-25809 # Atmospheric refraction of sonic boom from aircraft at low supersonic speeds. N. W. Page (Department of Supply, Aeronautical Research Laboratories, Melbourne, Australia). *American Institute of Aeronautics and Astronautics, Aero-Acoustics Conference, 2nd, Hampton, Va., Mar. 24-26, 1975, Paper 75-547.* 7 p. 5 refs.

This paper reports a study of atmospheric and flight conditions necessary for vertical reversal of ray paths either above or below an aircraft flying at Mach numbers between 1 and 1.15. Analytical solutions were obtained for the height for vertical reversal in a standard atmosphere with horizontal winds varying linearly with altitude. Both the height for vertical reversal of ray paths and ray path curvature were found to depend on a single non-dimensional refraction parameter which expresses the relative importance of refraction caused by vertical gradients of wind and temperature. (Author)

A75-25861 # Air traffic control (Control de la circulación aérea). J. Hernández Raposo. *Ingeniería Aeronáutica y Astronáutica*, vol. 26, Sept.-Oct. 1974, p. 7-18; Discussion, p. 18-22. In Spanish.

The processes of air traffic control are related to two phases, including a planning phase and a corrective phase. The first phase is concerned with the preparation of flight plans, taking into account questions of flight path geometry and flight schedules. The second phase involves the actual control of the aircraft during the flight. Attention is given to flight plans, questions regarding radar control systems, and the functions of the air traffic control center. The characteristics of the various generations of air traffic control systems used in succession since the 1950s are discussed along with specific questions concerning the air traffic control in Spain. G.R.

A75-25862 # The use of digital computers in air traffic control (La aplicación de los ordenadores al control de la circulación aérea). P. Tena López. *Ingeniería Aeronáutica y Astronáutica*, vol. 26, Sept.-Oct. 1974, p. 25-32; Discussion, p. 33, 34. In Spanish.

Aspects concerning the historical background of computer use are examined, taking into account the employment of computers in air defense projects and in air traffic control. The various types of

automatic air traffic control systems are considered. The advantages of automatization are discussed along with the use of computers in simulation studies, the elementary functions of automatization, automatization problems and restrictions, programming languages, operational problems, questions of reliability, and aspects of radar use. The establishment of an automatic ATC is described and attention is given to automatic control network systems in current use. G.R.

A75-25863 # Process of selection and quantization in the case of the fleet of Iberia (Proceso de selección y cuantificación de la flota de Iberia). L. Valenzuela Cervera. *Ingeniería Aeronáutica y Astronáutica*, vol. 26, Sept.-Oct. 1974, p. 41-54. In Spanish.

Considerations involved in an economic evaluation of the investment possibilities in the case of the Iberia Airlines of Spain are discussed. Commercial and traffic factors are examined, taking into account the air transport situation in the entire world, the conditions of air transport in Spain, questions regarding the participation of Spanish enterprises in international transport activities, an analysis of airport traffic, and aspects of Iberia development. Processes for the evaluation of alternative possibilities are considered, giving attention to the selection of traffic objectives and some specific examples concerning decisions involving the air fleet of Iberia. G.R.

A75-25874 Corporate/executive aircraft passenger safety - An educational approach. H. B. Altman (Interaction Co.). *SAFE Journal*, vol. 5, Spring 1975, p. 7-11. 22 refs.

A brief review is offered of the federal regulation for briefing passengers on aircraft safety and of the need to include the passenger as an integral, functional component in the aircraft safety system. Recent developments in aircraft passenger safety information systems are discussed. It is concluded that more emphasis should be placed on the development and use of efficient techniques of educating passengers on their role in aircraft emergencies. (Author)

A75-25878 Target identification by natural resonance estimation. A. J. Berni (Ohio State University, Columbus, Ohio). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-11, Mar. 1975, p. 147-154. 13 refs. Grant No. AF-AFOSR-74-2611.

The target identification method proposed is based on estimating the natural frequencies of oscillation in transient radar signatures. The overall approach is based on signal modeling and estimation strategy rather than on relating resonance locations to physical structures. Theoretical formulations are derived which indicate that successful estimation is possible when the response can be represented by a finite number of dominant resonances. Simulations based on the use of hypothesized transfer functions that contain a finite number of resonances are presented. Distinctive features of the method is that the target aspect angle is not needed, that bandpass interrogation pulses may be used, and that multiple targets of the same type can be illuminated simultaneously. Electromagnetic applications may include not only aircraft but also satellite and missile identification systems. V.P.

A75-25879 VTOL flight-control system design using sensitivity analysis. G. W. Carlock (Bell Helicopter Co., Fort Worth, Tex.) and A. P. Sage (Virginia, University, Charlottesville, Va.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-11, Mar. 1975, p. 155-161. 12 refs.

A particular design approach to the combined estimation and control problem (resulting in a closed-loop system) is proposed and is used to derive performance algorithms for use in sensitivity and error analysis. The combined estimation and control approach to VTOL system synthesis is outlined, and VTOL system modeling concepts are discussed. As an example, the algorithms are applied to the synthesis of a longitudinal motion VTOL hover controller. A

trade-off study based on the use of the sensitivity and error analysis algorithms proposed led to a highly effective sensor equipment package for the controller. V.P.

A75-25926 Laterally displaced ISLS antenna for tactical radar. N. Marchand (Marchand Electronic Laboratories, Inc., Greenwich, Conn.) and D. Riva (USAF, Electronics Systems Div., Bedford, Mass.). *Navigation*, vol. 21, Winter 1974-1975, p. 326-332. 9 refs. Contract No. F19628-71-C-0116.

The design, fabrication and testing of an experimental Antenna Modification Kit providing an Interrogation Side Lobe Suppression (ISLS) capability to the beacon subsystem of Radar Set AN/TPS-43 is described. It requires no modification of the radar antenna or pedestal. The experimental Antenna Modification Kit was installed at an AN/TPS-43 radar site and flight tested. Flight test results demonstrated an overall suppression efficiency of 95.4%, with no adverse side effects on system performance. On the basis of the flight test results, a recommendation is made to consider the use of an operational Kit of similar design as a solution to existing problems in the field caused by excessive side lobe returns and the FAA requirement for ATCRBS beacon ISLS. (Author)

A75-25928 Surveillance velocity measurements with least maximum error. J. M. Holt and R. H. Hamilton (McDonnell Douglas Electronics Co., St. Charles, Mo.). *Navigation*, vol. 21, Winter 1974-1975, p. 351-356.

The surveillance/separation assurance function used for automated air traffic control to insure safety on near parallel airways is optimized by deriving the best possible compromise between noise- and acceleration-induced errors as a function of measurement accuracy, acceleration magnitude and sampling frequency. It is found that an error allowance of 30 kt would be adequate with 97.7% confidence, provided 58 position measurements spaced 0.1 sec apart were available. Very fine measurements are thus required to obtain small speed measurement allowances, so that it is presently not possible to achieve separation standards through surveillance measured speed only. As sampling frequency is increased, the assumption of independent measurement errors becomes tenuous. S.D.

A75-25951 Ultrasonic flowmeter cell designs for liquids. L. C. Lynnworth (Panametrics, Inc., Waltham, Mass.). In: *Ultrasonics Symposium*, Milwaukee, Wis., November 11-14, 1974, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1974, p. 678-681.

Ultrasonic flowmeter cells have been designed, built and tested on flowing liquids including: liquid nitrogen, water, aviation gasolines JP4 and marine diesel DF1, and at 270 C, a prepolymer. The cells have flow channels of square, rectangular or circular cross sections, ranging from 1.27 to 30 cm across by 10 to 200 cm long. The interrogating ultrasonic waves, preferably transmitted upstream and downstream over a common path as simultaneously as practical, are introduced parallel, oblique or perpendicular to the flow axis. Transducers used to generate and detect these waves are sometimes mounted external to the pipe or cell. In other cases, recesses or penetrations are machined for geometric control of the sound beam. Here, internally-flush-mounted shims or screens are sometimes used, to minimize undesirable turbulence that would otherwise be generated at the transducer interruptions of the flow channel. (Author)

A75-25969 * Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Workshop sponsored by NASA, U.S. Navy, DOT, and FAA; Grant No. NsG-2024. Edited by J. F. Vittek, Jr. (MIT, Cambridge, Mass.). Cambridge, Mass., MIT Flight Transportation Laboratory, 1975. 708 p. \$25.

Papers are presented which review modern lighter-than-air (LTA) airship design concepts and LTA structures and materials technology, as well as perform economic and market analyses for assessment of the viability of future LTA development programs.

Potential applications of LTA vehicles are examined. Some of the topics covered include preliminary estimates of operating costs for LTA transports, an economic comparison of three heavy lift airborne systems, boundary layer control for airships, computer aided flexible envelope designs, state-of-the-art metalclad airships, aspects of hybrid-Zeppelins, the LTA vehicle as a total cargo system, unmanned powered balloons, and a practical concept for powered or tethered weight-lifting LTA vehicles.

P.T.H.

A75-25970 Where do we go from here. C. E. Rosendahl. In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. XIII-XVII.

Recent comments on new potential uses of LTA craft, particularly rigid airships, and on proposed improvements of them, are criticized because of their lack of realism. The buoyant hybrid is discussed, as well as various suggested structures and propulsion systems for the craft. The utility of rigid airships in intermediate-density cargo transport is pointed out. Limitations to the use of metal hulls, nuclear power, aggregate hulls, and overland travel are considered. Some misconceptions about the history of LTA aircraft are dispelled. S.J.M.

A75-25971 Basic relationships for LTA economic analysis. R. A. Ausrotas (MIT, Cambridge, Mass.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 1-6. 7 refs.

Operating costs for conventional lighter than air craft are presented, based upon data of actual and proposed airships. An economic comparison of LTA with the B-747F is shown. A brief discussion of possible LTA economic trends concludes the paper. (Author)

A75-25972 * Preliminary estimates of operating costs for lighter than air transports. C. L. Smith and M. D. Ardema (NASA, Ames Research Center, Moffett Field, Calif.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 7-19. 5 refs.

Presented is a preliminary set of operating cost relationships for airship transports. The starting point for the development of the relationships is the direct operating cost formulae and the indirect operating cost categories commonly used for estimating costs of heavier than air commercial transports. Modifications are made to the relationships to account for the unique features of airships. To illustrate the cost estimating method, the operating costs of selected airship cargo transports are computed. Conventional fully buoyant and hybrid semi-buoyant systems are investigated for a variety of speeds, payloads, ranges, and altitudes. Comparisons are made with aircraft transports for a range of cargo densities. (Author)

A75-25973 Comparative airship economics. R. Harthoorn (Holland America Line, Rotterdam, Netherlands). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 21-30. 9 refs.

Various cost considerations involved in the implementation of LTA vehicles are treated. It is emphasized that economy is the primary factor behind investor backing of any enterprise, and that this factor must be attended to in LTA design. The effect of speed on the capital return factor is discussed, and improving L/D ratio number only by economy of scale is considered. Thrust costs for various transport modes are outlined. S.J.M.

A75-25974 Effect of present technology on airship capabilities. R. T. Madden and F. Bloetscher (Goodyear Aerospace Corp., Akron, Ohio). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 31-40.

This paper presents the effect of updating past airship design using current materials and propulsion systems to determine new airship performance and productivity capabilities. New materials and power plants permit reduction in the empty weights and increases in the useful load capabilities of past airship designs. The increased useful load capability results in increased productivity for a given range, i.e., either increased payload at the same operating speed or increased operating speed for the same payload weight or combinations of both. Estimated investment costs and operating costs are presented to indicate the significant cost parameters in estimating transportation cost of payloads in cents per ton mile. Investment costs are presented considering production lots of 1, 10 and 100 units. Operating costs are presented considering flight speeds and ranges. (Author)

A75-25978 An economic comparison of three heavy lift airborne systems. B. H. Carson (U.S. Naval Academy, Annapolis, Md.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 75-85. 8 refs.

Current state of art trends indicate that a 50-ton payload helicopter could be built by the end of the decade. However, alternative aircraft that employ LTA principles are shown to be more economically attractive, both in terms of investment and operating costs for the ultra-heavy lift role. Costing methodology follows rationale developed by airframe manufacturers, and includes learning curve factors. (Author)

A75-25979 An approach to market analysis for lighter than air transportation of freight. P. O. Roberts, H. S. Marcus (MIT, Cambridge, Mass.), and J. H. Pollock. In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 87-110. 7 refs.

This paper presents an approach to marketing analysis for lighter-than-air vehicles in a commercial freight market. After a discussion of key characteristics of supply and demand factors, a three-phase approach to marketing analysis is described. The existing transportation systems are quantitatively defined and possible roles for lighter-than-air vehicles within this framework are postulated. The marketing analysis views the situation from the perspective of both the shipper and the carrier. A demand for freight service is assumed and the resulting supply characteristics are determined. Then these supply characteristics are used to establish the demand for competing modes. The process is then iterated to arrive at the market solution. (Author)

A75-25980 Market assessment in connection with lighter than air. J. E. R. Wood (Aerospace Developments, London, England). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 111-121.

A review of the marketability of the airship is given, and the relative energy consumption and speed potential of the airship is compared to other modes. Guidelines to areas of initial development are also provided, together with a brief historical review. (Author)

A75-25981 Basic relationships for LTA technical analysis. R. A. Ausrotas (MIT, Cambridge, Mass.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 123-131. 6 refs.

An introduction to airship performance is presented. Static lift equations are shown which, when combined with power requirements for conventional airships, allow parametric studies of range, payload, speed, and airship size. It is shown that very large airships are required to attain reasonable speeds at transoceanic ranges.

(Author)

A75-25982 The effects of selected modern technological concepts on the performance and handling characteristics of LTA vehicles. C. J. Mazza (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 133-146. 5 refs.

Results are presented of an airship design sensitivity study, itself a prelude to a more in-depth follow-up analysis. A variety of airship design concepts, including the classical and high aero-lift augmented hybrids, are examined with regard to specific technological improvements and consequent gains in performance, stability and control, and flying qualities. Variations in size, payload, power requirements, and airspeed are quantitatively analyzed for airships representing aero-to-buoyant lift ratios of zero to 3.0 over a range of technology improvements implying reduced drag, reduced structural weight fractions, and lighter, more efficient propulsion systems. Future airships are discussed qualitatively in terms of stability, control, and flying quality needs dictated by projected demands for vastly improved operational effectiveness and ease of handling. Topics included under this last category are stability augmentation systems, load-alleviation systems, and total computer state-sensing and controls management systems. S.J.M.

A75-25983 Boundary layer control for airships. F. A. Pake and S. J. Pipitone (Goodyear Aerospace Corp., Akron, Ohio). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 147-155.

This paper summarizes an investigation of the aerodynamic principle of boundary layer control for nonrigid LTA craft. The project included a wind tunnel test on a BLC body of revolution at zero angle of attack. Theoretical analysis is shown to be in excellent agreement with the test data. Methods are evolved for predicting the boundary layer development on a body of revolution and the suction pumping and propulsive power requirements. These methods are used to predict the performance characteristics of a full-scale airship. The analysis indicates that propulsive power reductions of 15 to 25 percent and endurance improvements of 20 to 40 percent may be realized in employing boundary-layer control to non-rigid airships.

(Author)

A75-25984 Airship stresses due to vertical velocity gradients and atmospheric turbulence. D. Sheldon (Transportation Technology, Inc., Marblehead, Mass.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 157-168. 13 refs.

Munk's potential flow method is used to calculate the resultant moment experienced by an ellipsoidal airship. This method is first used to calculate the moment arising from basic maneuvers considered by early designers, and then expended to calculate the moment arising from vertical velocity gradients and atmospheric turbulence. This resultant moment must be neutralized by the transverse force of the fins. The results show that vertical velocity gradients at a height of 6000 feet in thunderstorms produce a resultant moment approximately three to four times greater than the moment produced in still air by realistic values of pitch angle or steady turning. Realistic values of atmospheric turbulence produce a moment which is significantly less than the moment produced by maneuvers in still air. (Author)

A75-25985 An aerodynamic load criterion for airships. D. E. Woodward. In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 169-176. 16 refs.

This paper derives a simple aerodynamic bending moment envelope for conventionally shaped airships. This criterion is intended to be used, much like the Naval Architect's 'standard wave', for preliminary estimates of longitudinal strength requirements. It should be useful in trade-off studies between speed, fineness ratio, block coefficient, structure weight, and other such general parameters of airship design. (Author)

A75-25986 The planar dynamics of airships. F. J. Regan (U.S. Navy, Naval Ordnance Laboratory, Silver Spring, Md.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 177-186.

This paper will consider the forces and moments acting upon a LTA vehicle in order to develop parameters describing planar motion. Similar expressions for HTA vehicles will be given to emphasize the greater complexity of aerodynamic effects when buoyancy effects cannot be neglected. A brief summary is also given of the use of virtual mass coefficients to calculate loads on airships. (Author)

A75-25987 Floating vs flying - A propulsion energy comparison. F. Marbury (Ketrion, Inc., Arlington, Va.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 187-197. 5 refs.

Floating craft are compared to those that fly. Drag/weight for floaters is shown to be proportional to v^2/L , while for flyers it is independent of size and speed. The transportation market will therefore assign airships to lower speeds than airplanes, and will favor large airship sizes. Drag of an airship is shown to be only 11 percent of submarine drag at equal displacement and speed, raising the possibility that airships can compete with some types of ships. (Author)

A75-25988 Long fluid filled bags suspended by line forces. M. L. Mullins and J. L. Duncan (McMaster University, Hamilton, Ontario, Canada). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 199-208. 7 refs. Research supported by the National Research Council.

A previous analysis of fluid-filled storage bags is extended to the case of a long fluid-filled cylindrical membrane supported by uniform line loads. Cross-sectional shape, stiffness of the support system and stress resultants in the membrane are determined. The application of the numerical results to problems arising in the design of non-rigid airships is discussed. (Author)

A75-25989 Computer aided flexible envelope designs. R. D. Resch (Utah, University, Salt Lake City, Utah). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 209-215.

This paper will deal with two computer-aided design methods for the design and construction of strong, lightweight structures which require complex and precise geometric definition. The first, flexible structures, is a unique system of modeling folded plate structures and space frames. In the latter it is possible to continuously vary the geometry of a space frame to produce large, clear spans with curvature. The second method deals with developable surfaces where both folding and bending are explored with the observed constraint of available building materials and what minimal distortion would result in maximum design capability. (Author)

A75-25991 * LTA structures and materials technology. N. J. Mayer (NASA, Washington, D.C.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 223-241. 22 refs.

The state-of-the-art concerning structures and materials technology is reviewed. It is shown that many present materials developments resulting from balloon and aircraft research programs can be applied to new concepts in LTA vehicles. Both buoyant and semi-buoyant vehicles will utilize similar approaches to solving structural problems and could involve pressurized non-rigid and unpressurized rigid structures. System designs common to both and vital to structural integrity will include much of the past technology as well. Further research is needed in determination of structural loads, especially in future design concepts. (Author)

A75-25992 Potential contribution of high strength, high modulus aramid fibers to the commercial feasibility of lighter than air craft. D. L. G. Sturgeon and T. K. Venkatachalam (Du Pont de Nemours and Co., Inc., Wilmington, Del.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 243-255. 9 refs.

A75-25993 Operational considerations for the airship in short-haul transportation. C. D. Walker (Aerling, Bedford, Ind.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 261-266. 7 refs.

This paper surveys the airship's problems and the possibilities for their solution in a short-haul transportation environment. The problems are derived from both past experience and envisioned operation. Problems relative to both fully buoyant and semibuoyant configurations are considered and their origins in principle discussed. Also addressed in this paper are the state-of-the-art technologies with the potential of providing answers to the airship's operational difficulties. (Author)

A75-25994 Design aspects of zeppelin operations from case histories. W. P. Maersperger. In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 267-283. 36 refs.

This paper deals with some widely held beliefs concerning the practicability of rigid airships in air carrier operations. The paper shows, by a review of past operational experience, and some basic aerostatic theory, their actual record and the reasons for their demise. Problems of atmospheric density and temperature variations, meteorological factors, aerodynamic stability and control, and mooring difficulties are discussed and related to actual case histories. Structural and flight efficiencies are compared to airplane efficiencies for airplanes contemporary with the zeppelin as well as modern designs. The difficulty of supporting new, commercial airship developments on an economic basis is made clear. (Author)

A75-25995 Lighter than air - A look at the past, a look at the possibilities. W. F. Shea (California State, Dept. of Transportation, Sacramento, Calif.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 285-295. 31 refs.

The use of lighter-than-air airships as a feasible economic method of flight is reviewed from the first hot-air balloon flight in 1783. Some famous airships are described, including the Hindenburg and the U.S. ZMC-2 and K-class nonrigid blimps. The problems associated with the high power output and large storage areas needed

for airships are described, and some arguments for and against nuclear powered airships and predicted cruising speeds and load capacities are presented. Potential peacetime uses of airships for hauling very large cargo loads and their vulnerability in military operations and inclement weather are discussed. F.G.M.

A75-25996 Mooring and ground handling rigid airships. H. Walker, Jr. In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 297-310. 7 refs.

This paper will deal with the problems of mooring and ground handling rigid airships. A brief history of mooring and ground handling of rigid airships from July 2, 1900 through September 1, 1939 is included. Also a brief history of ground handling developments with large U.S. Navy nonrigid airships between September 1, 1939 and August 31, 1962 is included wherein developed equipment and techniques appear applicable to future large rigid airships. Finally, recommendations are made pertaining to equipment and procedures which appear desirable and feasible for future rigid airship programs. (Author)

A75-25997 A new concept for airship mooring and ground handling. J. C. Vaughan (U.S. Naval Air Systems Command, Washington, D.C.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 311-321.

Calculations have been made to determine the feasibility of applying the Negative Air Cushion (NAC) principle to the mooring of airships. Pressures required for the inflation of the flexible trunks are not excessive and the maintenance of sufficient hold down force is possible in winds up to 50 knots. Fabric strength requirements for a typical NAC sized for a 10-million cubic foot airship were found to be approximately 200 lbs/in. Corresponding power requirements range between 66-HP and 5600-HP. No consideration has been given to the internal airship loads caused by the use of a NAC and further analysis in much greater detail is required before this method could be applied to an actual design, however, the basic concept appears to be sound and no problem areas of a fundamental nature are apparent. (Author)

A75-25998 The Slate all metal airship. C. C. Slate (Slate All Metal Dirigible Co., Glendale, Calif.) and R. Neumann. In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 323-330.

This paper recounts the development of the Slate all-metal airship 'City of Glendale' built and completed in 1930. A brief discussion of the airship facilities is given. Pertinent data which led to other engineering accomplishments for aviation will be covered. The paper deals with the SMD-100 concept, along with a brief commentary on the costs and problems involved in such an airship design and the application of the hoisting and elevator facilities to airship development. (Author)

A75-25999 State of the art of metalclad airships. V. H. Pavlecka and J. Roda (Turbomachines, Inc., Irvine, Calif.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 331-349. 8 refs.

The historical background of airships is considered along with modern metalclad airship possibilities. Significant gains made in a number of areas related to the design of metalclad airships are discussed, giving attention to materials, structure, hull plating, forward and reverse propulsion, the control of the boundary layer in flight, the use of thrusters for the control of airships, and the

thermodynamic management of lift. It is recommended to construct the larger airships of the future as load carriers, with exchangeable containers. G.R.

A75-26000 The aerospace developments concept. J. E. R. Wood (Aerospace Developments, London, England). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 351-358.

A project assessing the viability of using airships for the transport of natural gas, completing the design of the airship and its associated ground structures, and carrying out a continuing economic analysis on itself is described. Unnecessary expense incurred in cryogenic tanker natural gas transport, the choice of type of LTA aircraft (supported Monocoque), the basic system of construction featuring the 'unitary panel', powering requirements, the building facility for the craft, gassing and degassing the ship, and the prototype program are discussed. S.J.M.

A75-26001 Method for transporting impellent gases. H. Papst (Papst-Motoren, St. Georgen, West Germany). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 359-367.

The described system DAL comprises a method and a device for transportation of buoyant impellent gases, without the need for expensive pipes and liquid tankers. The gas is self air-lifted from its source to a consignment point by means of voluminous, light, hollow bodies. Upon release of the gas at the consignment point, the bodies are filled with another cheap buoyant gas (steam or heated air) for the return trip to the source. In both directions substantial quantities of supplementary freight goods can be transported. Requirements and advantages are presented. (Author)

A75-26002 The design and construction of the CAD-1 airship. H. J. Kleiner, J. L. Duncan (McMaster University, Hamilton, Ontario, Canada), and R. Schneider (Canadian Airship Development Corp., Thornhill, Ontario, Canada). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 369-394. 5 refs.

The present work deals with the background history, design philosophy, and computer application relating to the design of the envelope shape, stress calculations, and flight trajectories of the CAD-1 airship currently under construction. A three-phase proposal for future development of larger cargo-carrying airships is also outlined. The development program would start with small-scale activities and move toward larger-scale ones, economically promising vehicles and actual freight operations. Phase I would consist of operating and training, application assessment, and engineering design. Phase II would include realistic operational trials of CAD-2, designed in phase I, with some time spent on scheduled freight movements; design of an economically feasible commercial vehicle would continue. Phase III would seek to complete the detail design and to construct a prototype of the economical carrier. Numerous figures concerning physical parameters of the airship illustrate the text. S.J.M.

A75-26003 An LTA flight research vehicle. F. R. Nebiker (Goodyear Aerospace Corp., Akron, Ohio). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 395-404.

Major program objectives are summarized and a modernized Navy ZPG-3W airship is recommended as a flight test vehicle for an LTA flight research project. The origin of current interest in modern airship vehicles is briefly discussed, and the major benefits resulting from the proposed flight research program are described. Ecological and energy factors, modern airship capabilities, application of

current technology to airships, modern airship missions, modern airship problems and technical limitations, economic uncertainty, and institutional uncertainties and constraints are considered. S.J.M.

A75-26004 The Airfloat HL project. E. Mowforth (Airfloat Transport, Ltd.; Surrey University, Guildford, England). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 405-414.

This paper describes a design study for a large low-cost rigid airship intended primarily for the movement of large indivisible loads between unprepared sites. A survey of the ship and its overall performance is followed by accounts of the operational procedures for the above function and for an alternative application to unit module transfer between fixed terminals. A final section indicates the estimated costs of construction and operation. (Author)

A75-26005 The basic characteristics of hybrid aircraft. J. B. Nichols (United Technical Industries, El Segundo, Calif.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 415-430.

General considerations involved in the design of hybrid aircraft are outlined, and detailed treatments of separate hybrid aircraft parameters (buoyant gas alternatives, lifting volume geometries, wing design, airframe weight, effects of size, and propulsion systems) are provided. It is pointed out that surface area must be minimized in order to reduce structural weight and that volume must be maximized in order to increase aerostatic lift, but also that required surface area tends to grow as more aerodynamic lift is desired and that volume decreases as more efficient wing shapes are employed. The problems of drag and thrust are emphasized. S.J.M.

A75-26006 * A semibuoyant vehicle for general transportation missions. C. D. Havill and M. Harper (NASA, Ames Research Center, Moffett Field, Calif.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 431-439.

The concept of small, semibuoyant, lifting-body airships is discussed. Estimates of important performance characteristics are made and compared with other flight vehicle systems. (Author)

A75-26007 The Dynairship. W. M. Miller, Jr. (Aereon Corp., Princeton, N.J.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 441-455.

A recently developed 'aerobody' is described that is a blend of two concepts: a buoyant-lift airship and a dynamic-lift airplane. Some of the developmental history involved is discussed. The Dynairship, as it is called, is a large, triangularly-shaped vehicle. The innovations entailed in its construction and application are considered. Much research remains to be done in technological and economic related fields. S.J.M.

A75-26008 Some aspects of Hybrid-Zeppelins. P.-A. Mackrodt (Göttingen, Flugwissenschaftliche Fachgruppe, Göttingen, West Germany). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 457-464. 6 refs.

To increase an airship's maneuverability and payload capacity as well as to save buoyant gas it is proposed to outfit it with a slender delta-wing, which carries about one half of the total take-off weight of the vehicle. An optimization calculation based on the data of LZ

129 (the last airship, which saw passenger-service) leads to an Hybrid-Zeppelin with a wing of aspect-ratio 1.5 and 105 m span. The vehicle carries a payload of 40% of its total take-off weight and consumes 0.8 t fuel per ton payload over a distance of 10,000 km.

(Author)

A75-26009 Ultra-heavy vertical lift system 'The Heli-Stat'. F. N. Piasecki (Piasecki Aircraft Corp., Philadelphia, Pa.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 465-476. 5 refs.

The Heli-Stat is a novel hybrid VTOL vehicle comprised of an aerostat combined with helicopters. The static lift of the aerostat supports approximately the full empty weight of the entire assembly. The helicopter rotors furnish the lift to support the payload as well as the propulsion and control about all axes. Thus existing helicopters, with no new technology required, can be made to lift payloads of ten times the capacity of each one alone, and considerably more than that of any LTA built so far. A vehicle is described which has a 75-ton payload, based on four existing CH-53D helicopters and an aerostat of 3,600,000 cu ft. The method of interconnection is described along with discussion of control, instrumentation, drive system and critical design conditions. (Author)

A75-26010 The variable density aircraft concept. A. C. Davenport (Dynapods, Inc., New Orleans, La.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 477-483.

Difficulties concerning the operation of an airship are related to the fixed mass concept. The variable density aircraft solves the airship's dilemma by combining a 'dynapod' with an intrinsic means for its expansion and contraction. A dynapod is defined as an articulated, variable volume, variable geometry, zero differential pressure, constant surface area hull. It is a hull of square cross section, the sides of which are hinge-joined to allow the figure to vary its geometry and volume. Approaches for the variation of the dynapod volume are discussed along with a simulated flight of the variable-density aircraft and the use of the new aircraft type as a very convenient and economical means of transportation. G.R.

A75-26012 The application of the airship to regions lacking in transport infrastructure. S. Coughlin (Cranfield Institute of Technology, Cranfield, Beds., England). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 499-507.

This paper considers the requirements for two areas of airship application. The first of these are those countries where there is a need to move consignments that are too large for the existing transport systems, and secondly those regions where ground characteristics have resulted in an area totally devoid of transport. The needs of the second group are considered in detail since they also require transport to provide social as well as economic growth. With this problem in mind, a philosophy is put forward for using airships in conjunction with LASH vessels. A specimen design is outlined and the initial costs estimated. (Author)

A75-26013 Military applications of rigid airships. B. B. Levitt (Operations Research, Inc., Silver Spring, Md.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 509-515.

The objective of this paper is to examine military roles and missions for which the rigid airship appears to be suited, and to suggest specific applications that the airship could potentially perform in an effective manner. Principal missions examined are the movement of military cargo and the surveillance aspects of the sea control mission. (Author)

A75-26014 Potential ASW missions for lighter than air ships. R. S. Stone, B. O. Koopman, and G. Raisbeck (Arthur D. Little, Inc., Cambridge, Mass.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 517-525.

This paper deals with the LTA as a potential counter to the ballistic and cruise missile launching submarine. The LTA ship can deploy a wide variety of submarine detection equipments effectively. Its long endurance, high speed, and large weapons inventory capability, coupled with the facts that it need not alert a potential submarine target as to its presence, and that it is essentially immune to attack by submarines indicate that it would prove to be a highly effective ASW unit. (Author)

A75-26015 Airship logistics - The LTA vehicle, a total cargo system. L. R. Hackney (Hackney Associates, Sierra Madre, Calif.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings.

Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 531-538. 15 refs.

This paper deals with the design considerations for logistics, as they pertain to the large rigid LTA vehicle as either a commercial or military cargo carrier. Pertinent factors discussed are: (1) the basic mission; (2) types of payload; (3) the payload space in regards to configuration and sizing, its capacity, and its loadability. A logistic capability comparison of selected cargo airships versus jumbo jets is also made. (Author)

A75-26016 The transport of nuclear power plant components. S. J. Keating, Jr. (Combustion Engineering, Inc., Windsor, Conn.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings.

Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 539-549.

This paper deals with the problems of transporting nuclear power plant components to landlocked sites where the usual mode of transport by barge cannot be used. Existing method of ground-based overland transport are discussed and their costs presented. Components are described and traffic density projections made to the year 2000. Plots of units transported versus distance transported are provided for units booked in 1973 and booked and proposed in 1974. It is shown that, for these cases, overland transport requirements for the industry will be over 5,000,000 ton-miles/year while a projection based on increasing energy demands shows that this figure will increase significantly by the year 2000. The payload size, distances, and costs of existing overland modes are significant enough to consider development of a lighter than air (LTA) mode for transporting NSSS components. (Author)

A75-26017 Airships for transporting highly volatile commodities. M. Sonstegaard (Arkansas, University, Fayetteville, Ark.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 551-558. 12 refs.

A three-way comparison between airships, ocean tankers, and pipelines as transporters of volatile commodities is provided. It is said that the airship has power economy advantages over the pipeline, speed advantages over the tanker, and direct routing advantages over both these modes. But serious problems of safety, storm avoidance, and wind regime utilization are posed by the use of airships. S.J.M.

A75-26018 Using lighter than air vehicles /dirigibles/ in housing construction. E. E. Shamis (Kishinevskii Politekhnikeskii Institut, Kishinev, Moldavian SSR) and V. B. Moorychev (Public Dirigible Design Office, Leningrad, USSR). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 559-562.

This paper reports on the potential use of Lighter Than Air vehicles for the transport and erection of modular housing units. Comparisons are made between traditional methods of construction and the use of an airship. Data on LTD cost is based on an airship design study and the operation of a 12 meter model. (Author)

A75-26019 **Aerocrane - A hybrid LTA aircraft for aerial crane applications.** R. G. Perkins, Jr. (U.S. Naval Air Systems Command, Washington, D.C.) and D. B. Doolittle. In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 571-584.

The use of the helicopter as an aerial crane is restricted by its low gross lifting capacity, high cost, and low operational reliability. The Aerocrane is a hybrid lighter-than-air aircraft designed to overcome helicopter deficiencies in applications requiring the lifting of heavy loads. The basic concept of the new aircraft type is to integrate the controllable thrust vector of a rotary wing system with the lifting capability of a heavy lift balloon. Aerostatic lift supports two-thirds of the aircraft design takeoff weight, while aerodynamic lift only supports the remaining 50% of the sling load. Aerocrane design details are discussed, giving attention to lift distribution, rotor characteristics, forward flight performance, and aerocrane blade environment. G.R.

A75-26020 **Unmanned powered balloons.** A. O. Korn (USAF, Cambridge Research Laboratories, Bedford, Mass.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 585-594. 7 refs.

The present work describes some of the history of powered balloons, as well as more recent low- and high-altitude balloon flights and studies still in the design phase. High Platform I is discussed; it used an electrically driven propeller and tested a prototype silicon solar array, although the array did not yet power the propeller. High Platform II was powered by solar cells, but serious technical problems were revealed during its test flights. POBAL, powered by 2000 lbs of dry cells, has a deficient rudder assembly and insufficient airspeed. Silent Joe I and II and Micro Blimp are the low-altitude models described. Studies concerning remaining problems concentrate on drag coefficient, propeller design and propeller performance prediction, and long-duration solar cell power. S.J.M.

A75-26021 **Special problems and capabilities of high altitude lighter than air vehicles.** P. R. Wessel and F. J. Petrone (U.S. Navy, Naval Ordnance Laboratory, Silver Spring, Md.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 595-603. Navy-supported research.

The high-altitude super-pressure powered aerostat (HASPA) program, still in the design phase, is discussed and related to general LTA technology. Operating altitude will be in the 70,000 foot range; hull shape will resemble that of conventional airships; fabric selection and material strength will depend on a number of factors; power requirements will result mainly from propulsion, but payload operation and control-telemetry will also make energy demands; and power sources will be either primary or regenerative. Applications are briefly discussed. S.J.M.

A75-26022 **A practical concept for powered or tethered weight-lifting LTA vehicles.** M. A. Baileyguyer (La Grue Volante, Chaville, Hauts-de-Seine, France). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 605-612.

This paper sets forth a concept for a multi-hull weight-lifting airship. In the flight test, two barrage balloons were joined side-by-side, with an intermediate frame, and launched in captive flight. The success of this flight test led to plans for a development

program calling for a powered, piloted prototype, a follow-on 40-ton model, and a 400-ton transport model. All of these airships utilize a tetrahedric three-line tethering method for loading and unloading phases of flight, which bypasses many of the difficulties inherent in the handling of a conventional airship near the ground. Both initial and operating costs per ton of lift capability are significantly less for the subject design than for either helicopters or airships of conventional mono-hull design. (Author)

A75-26023 **A revolutionary and operational tethered aerostat system illustrating new LTA technology.** J. A. Menke (Sheldahl, Inc., Northfield, Minn.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 613-622.

A tethered aerostat system, which demonstrates utility of LTA systems, has been in operation for about one year. It was made possible by development of a reliable tethered aerostat that is used to support broadcast equipment at an altitude of 10,000 feet. Two elements of the TCOM system, the aerostat and mooring station, both designed and manufactured by Sheldahl, are particularly relevant to the LTA Workshop. They demonstrate the feasibility of using LTA vehicles in real, operational, all-weather applications and, in addition, illustrate an advance in the overall technology base of LTA. This paper presents a description of the aerostat and the mooring station including their technical design features and demonstrated performance characteristics. (Author)

A75-26024 **Technology update - Tethered aerostat structural design and material developments.** R. G. Witherow (Sheldahl, Inc., Northfield, Minn.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 623-635.

Requirements exist for an extremely stable, high performance, all-weather tethered aerostat system. This requirement has been satisfied by a 250,000 cubic foot captive buoyant vehicle as demonstrated by over a year of successful field operations. This achievement required significant advancements in several technology areas including composite materials design, aerostatics and aerodynamics, structural design, electro-mechanical design, vehicle fabrication and mooring operations. This paper specifically addresses the materials and structural design aspects of pressurized buoyant vehicles as related to the general class of Lighter Than Air vehicles - the subject of this Workshop. (Author)

A75-26025 **Two lighter than air systems in opposing flight regimes - An unmanned short haul, heavy load transport balloon and a manned, light payload airship.** R. A. Pohl (Raven Industries, Inc., Sioux Falls, S. Dak.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 637-650.

Lighter Than Air Vehicles are generally defined or categorized by the shape of the balloon; payload capacity and operational flight regime. This paper describes two balloon systems that are classed as being in opposite categories. One is a cable guided, helium filled, short haul, heavy load transport Lighter Than Air system with a natural shaped envelope. The other is a manned, aerodynamic shaped airship which utilizes hot air as the buoyancy medium and is in the light payload class. While the airship is in the design/fabrication phase with flight tests scheduled for the latter part of 1974, the transport balloon system has been operational for some eight years. (Author)

A75-26026 **Balloon logging with the inverted skyline.** C. F. Mosher (Mosher Balloon Systems, Inc., Eugene, Ore.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cam-

bridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 651-666.

A proposed balloon logging system is discussed in terms of ecological benefits and cost factors. The system will feature a powerful carriage mounted on an inverted skyline and supported by a large, low-drag, blimp-shaped balloon. Cost will be within the \$30/thousand board feet range, and construction will be less expensive than certain suggested helicopter systems. Standing tree logging and its concomitant benefits in worker safety, fire risk reduction, felled-tree waste, sidehill falling and bucking expenses, nighttime logging possibilities, and year-round logging are indicated. Potential for uphill logging and use of a flywheel powered by empty uphill runs of the balloon, as well as use of the potential energy of sidehill trees, are discussed. S.J.M.

A75-26027 'LOTS' of LTA applications. J. S. Brown (U.S. Navy, Plans, Programs, and Naval Control of Shipping Office, Washington, D.C.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 667-677. 11 refs.

This paper will briefly describe current problems facing the logistical planner in utilizing the new ships of the modern, intermodal sea transportation systems in a logistics-over-the-shore (undeveloped) environment. Then the employment of two potential LTA vehicle systems is described and discussed as significant parts of possible solutions to this range of logistical problems. Vulnerability aspects of these LTA vehicles are also briefly addressed because of their possible employment near combat areas. (Author)

A75-26028 Remotely piloted LTA vehicle for surveillance. G. R. Seemann, G. L. Harris, G. J. Brown (Developmental Sciences, Inc., City of Industry, Calif.). In: Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings. Cambridge, Mass., MIT Flight Transportation Laboratory, 1975, p. 679-683.

The present work deals with the various aspects of a remotely piloted mini-LTA (lighter-than-air) vehicle for surveillance, monitoring and measurement in civilian and military applications. Applications, operations, and economics are discussed. A blimp design of about 5000 sq ft, 55 ft in length and 13 ft in diameter has been selected for the remotely piloted vehicle (RPV). Advantages of the LTA vehicle over current HTA craft include endurance, good top speed, low pollution, no minimum speed, low vibration levels, low maintenance, stable platform, safety to ground personnel and property, flexibility (versatility), economy, low operator skill requirements, low radar cross-section, and ease of launch and recovery. S.J.M.

A75-26037 Advanced signal processing for airport surveillance radars. R. M. O'Donnell, C. E. Muehe, M. Labitt, W. H. Drury, and L. Cartledge (MIT, Lexington, Mass.). In: EASCON '74; Electronics and Aerospace Systems Convention, Washington, D.C., October 7-9, 1974, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1974, p. 71-71F. 10 refs. U.S. Department of Transportation Contract No. FA72-WAL-242; Contract No. F19628-73-C-0002.

The requirements which must be met by automated airport surveillance radars are examined, taking into account low false alarm rates and high probabilities of aircraft detection in the presence of extraneous clutter reflections. Approaches for obtaining surveillance systems with the desired requirements are described, giving attention to questions of optimum processing the implementation of a near-optimum processor, and thresholding problems. Experiments conducted to test the outlined signal processing concepts are discussed. G.R.

A75-26038 Millimeter radar for low angle tracking. F. Kittredge, E. Ornstein, and M. C. Licitra (U.S. Navy, Naval Research Laboratory, Washington, D.C.). In: EASCON '74; Electronics and

Aerospace Systems Convention, Washington, D.C., October 7-9, 1974, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1974, p. 72-75.

A millimeter monopulse tracking radar has been developed and is currently under preliminary testing. Accurate aircraft tracking at altitudes of 100 feet to 18 miles range has been demonstrated. The precision of these preliminary measurements is influenced by several factors not directly related to mm frequencies. These are: (1) a complex mechanical structure with related resonance problems, and (2) some unresolved servo mechanism problems which affect antenna pointing capability. However, it is clearly demonstrated that millimeter monopulse radar does improve low angle tracking capability. Further testing and refinement of the system should lead to a considerable improvement in tracking precision capability. (Author)

A75-26041 High range-resolution monopulse tracking radar and applications. D. D. Howard (U.S. Navy, Naval Research Laboratory, Washington, D.C.). In: EASCON '74; Electronics and Aerospace Systems Convention, Washington, D.C., October 7-9, 1974, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1974, p. 86-91.

Conventional high range resolution radars can resolve a typical target such as an aircraft into many parts giving a detailed range-amplitude profile of the target. High Range Resolution Monopulse (HRRM) adds the capability for two additional dimensions of detailed target data, azimuth and elevation. Wide instantaneous bandwidth is maintained through range and angle error sensing channels so the high range-resolution monopulse can provide range, azimuth, elevation, and amplitude for each resolved part of the target. The 3-D radar target detail can be used for improved precision of target location, for target classification and recognition, to counter repeater type ECM, to improve low-angle multipath tracking, or to resolve multiple targets, as a miss-distance indicator, and for improved tracking in chaff and clutter. (Author)

A75-26043 AEROSAT test and evaluation avionics. R. H. Sahmel (Aerospace Corp., El Segundo, Calif.) and R. D. Jones (FAA, Washington, D.C.). In: EASCON '74; Electronics and Aerospace Systems Convention, Washington, D.C., October 7-9, 1974, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1974, p. 99-106. 5 refs.

The objectives of the AEROSAT program are to provide the technical, operational, and managerial experience that will enable the development of an operational oceanic air traffic control system using an aeronautical satellite communications system. The AEROSAT avionics are designed with maximum flexibility to meet these objectives. Avionics system and subsystem configurations are presented that will allow technical and operational performance evaluation of a number of techniques for voice and data communications between ground and aircraft, experimental evaluation of surveillance concepts, evaluation of various access control techniques and a comparison of VHF and L-band frequencies for satellite communications. (Author)

A75-26059 An overview of the upgraded third generation air traffic control system. D. R. Israel (FAA, Washington, D.C.). In: EASCON '74; Electronics and Aerospace Systems Convention, Washington, D.C., October 7-9, 1974, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1974, p. 244-249.

With the continuing growth of aviation, improvements to our current air traffic control system will be required. The system planned for use in the 1980s and beyond is now known as the Upgraded Third Generation System (UG3RD). It is designed to meet the FAA's goals of: (1) maintaining or improving safety, (2) constraining or reducing costs, and (3) increasing or improving performance. The system will be characterized by nine major features - Intermittent Positive Control (IPC), the Discrete Address Beacon System (DABS), Area Navigation (RNAV), Microwave

Landing System (MLS), Increased Automation, Airport Surface Traffic Control (ASTC), a Wake Vortex Avoidance System (WVAS), Flight Service Stations (FSS), and Aeronautical Satellites (AEROSAT). (Author)

A75-26060 Status of the wake vortex avoidance system. J. N. Hallock and W. D. Wood (U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.). In: EASCON '74; Electronics and Aerospace Systems Convention, Washington, D.C., October 7-9, 1974, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1974, p. 250-256. 8 refs.

The current status of a wake vortex avoidance system (WVAS) being developed to detect and/or predict the presence of dangerous wake vortices in terminal airspace is reviewed. The WVAS system will evaluate the hazard and will command the hazard avoidance action. The system concepts are outlined, and such modules of the WVAS as the vortex detecting and tracking systems, the predictive model and data base, and the hazard model are discussed. The work remaining to be done includes measurement of the strength of vortices during the aging process, determining the effect of drifting vortices on parallel runways, testing of candidate sensors and system configurations, and the continuation of data collection. V.P.

A75-26061 DABS - Projected performance and experimental results. P. R. Drouilhet (MIT, Lexington, Mass.). In: EASCON '74; Electronics and Aerospace Systems Convention, Washington, D.C., October 7-9, 1974, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1974, p. 257-263. FAA-sponsored research.

The central design objectives of the Discrete Address Beacon System (DABS) include the provision of reliable surveillance and data-link communication for all aircraft and a support of automated ATC, including intermittent positive control (IPC), in the projected 1995 traffic environment. The improved surveillance capability of DABS is to be achieved by adding a discrete address mode as an evolutionary enhancement of the air traffic control radar beacon system. G.R.

A75-26062 Ground-based collision avoidance systems for air traffic. L. G. Culhane and B. M. Horowitz (Mitre Corp., McLean, Va.). In: EASCON '74; Electronics and Aerospace Systems Convention, Washington, D.C., October 7-9, 1974, Record.

New York, Institute of Electrical and Electronics Engineers, Inc., 1974, p. 264-271. 6 refs.

This paper presents analytical, simulation and experimental results which have been obtained in the process of designing and progressing toward the implementation of ground-based collision avoidance systems for air traffic control. Selective subsystem performance criteria established as part of the design process are also presented. Two different, but compatible system concepts are discussed. Firstly, for situations involving IFR aircraft, a conflict alert capability will provide the controller with a displayed alert of impending situations of separation being less than minimums. Secondly, an Intermittent Positive Control (IPC) function, utilizing data link and improved surveillance, provides an automated collision avoidance capability for VFR/VFR and VFR/IFR aircraft pairs, and provides an independent backup to the ATC system for IFR aircraft pairs. In addition, IPC includes pilot warning indications (PWI) for informing pilots of the location of proximate aircraft. (Author)

A75-26064 Test bed for the upgraded third generation Air Traffic Control System. A. A. Lupinetti and L. F. Stinson (FAA, National Aviation Facilities Experimental Center, Atlantic City, N.J.). In: EASCON '74; Electronics and Aerospace Systems Convention, Washington, D.C., October 7-9, 1974, Record.

New York, Institute of Electrical and Electronics Engineers, Inc., 1974, p. 280-287.

The elements of the upgraded third generation ATC system include intermittent positive control, the discrete address beacon

system, flight service stations, upgraded automation functions, airport surface traffic control, a wake vortex avoidance system, area navigation, a microwave landing system, and AEROSAT. The integrated test bed which is used for the evaluation of the new concepts is considered, taking into account the terminal radar beacon test facility, the en route system support facility, the digital simulation facility, the terminal automation test facility, and the support systems. G.R.

A75-26099 Warranties as a life-cycle-cost management tool. C. R. Knight (ARINC Research Corp., Annapolis, Md.). In: EASCON '74; Electronics and Aerospace Systems Convention, Washington, D.C., October 7-9, 1974, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1974, p. 621-623.

The use of warranties to control life-cycle costs of military equipment is considered as an alternative to standard procurement approaches. It is shown that warranties would make the manufacturer responsible for a major portion of life-cycle costs and would have a positive effect on equipment reliability. Examples of warranty use in military procurement are presented, including the repair and refurbishment of gyros in the Navy's A-4 and F-4 and the Air Force's F-111 aircraft and warranty agreements for the Navy's AN/APN-194 altimeter, AN/APN-99(V-1) Omega receiver, and an aircraft hydraulic pump. Disadvantages of warranties, especially the possibility of dependence on commercial sources for maintenance usually performed on the operational level, are discussed. Arguments against warranty use for all military procurements are advanced. F.G.M.

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STAR ENTRIES

N75-17294* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
WIND TUNNEL INVESTIGATION OF AERODYNAMIC LOADS ON A LARGE-SCALE EXTERNALLY BLOWN FLAP MODEL AND COMPARISON WITH THEORY
 Boyd Perry, III and George C. Greene Washington Mar. 1975 99 p refs
 (NASA-TN-D-7863; L-9854) Avail: NTIS HC \$4.75 CSCL 01A

Results from a wind-tunnel investigation of a large-scale externally blown flap model are presented. The model was equipped with four turbofan engines, a triple-slotted flap system, and a T-tail. The wing had a quarter-chord sweep of 25 deg, an aspect ratio of 7.28, and a taper ratio of 0.4. Aerodynamic loads and load distributions were determined from a total of 564 static pressure orifices located on the upper and lower surfaces of the slat, wing, and flaps. Loads are presented for variations of angle of attack, engine thrust setting, and flap deflection angle. In addition, the experimental results are compared with analytical results calculated by using a potential flow analysis. Author

N75-17295* Honeywell, Inc., Hopkins, Minn. Government and Aeronautical Products Div.
ANALYSIS AND PRELIMINARY DESIGN OF AN ADVANCED TECHNOLOGY TRANSPORT FLIGHT CONTROL SYSTEM Final Report
 Ronald Frazzini and Darrel Vaughn Washington NASA Mar. 1975 424 p refs
 (Contract NAS1-12437)
 (NASA-CR-2490) Avail: NTIS HC \$10.50 CSCL 01C

The analysis and preliminary design of an advanced technology transport aircraft flight control system using avionics and flight control concepts appropriate to the 1980-1985 time period are discussed. Specifically, the techniques and requirements of the flight control system were established, a number of candidate configurations were defined, and an evaluation of these configurations was performed to establish a recommended approach. Candidate configurations based on redundant integration of various sensor types, computational methods, servo actuator arrangements and data-transfer techniques were defined to the functional module and piece-part level. Life-cycle costs, for the flight control configurations, as determined in an operational environment model for 200 aircraft over a 15-year service life, were the basis of the optimum configuration selection tradeoff. The recommended system concept is a quad digital computer configuration utilizing a small microprocessor for input/output control, a hexad skewed set of conventional sensors for body rate and body acceleration, and triple integrated actuators. Author

N75-17296* California Inst. of Tech., Pasadena. Graduate Aeronautical Lab.
THEORETICAL AND EXPERIMENTAL STUDY ON THE EJECTOR AUGMENTED JET FLAP Final Report
 H. J. Stewart 1 Aug. 1974 171 p refs
 (Grant NGR-05-002-239)
 (NASA-CR-136749) Avail: NTIS HC \$6.25 CSCL 01B

The analytical concept used in determining the characteristics of jet flap or related propulsive systems suitable for VTOL and

STOL applications was examined. The configuration chosen was a two dimensional wing with a biplane flap, having a jet injected on the upper surface of the wing at the flap hinge axis and discharging into the channel between the two elements of the flap. The experimental work was conducted in a two dimensional test installation in a subsonic wind tunnel. The model description, the test conditions, and a summary of the experimental results are presented. Author

N75-17297# European Space Research Organization, Paris (France).

A SPATIAL THEORY FOR THE GROUND RESONANCE OF HELICOPTERS

Rolf Schroeder Nov. 1974 181 p refs Transl. into ENGLISH of Eine Räumliche Theorie fuer die Bodenresonanz von Hubschraubern, DLR-FB-73-84, DFVLR, 22 Jun. 1973 (ESRO-TT-108; DLR-FB-73-84) Avail: NTIS HC \$7.00; DFVLR, Porz, West Ger. 30 DM

The vibration phenomena occurring during takeoff and landing of a helicopter were experimentally and theoretically investigated. The investigation covers vibrations of simplified two- and three-dimensional rotor systems. In the mathematical treatment additional degrees of fuselage freedom were taken into account. The existence of as yet unknown instability regions is pointed out with this extended theory. ESRO

N75-17298# Technische Hochschule, Darmstadt (West Germany). Inst. fuer Flugtechnik.

WIND TUNNEL INVESTIGATIONS ON AN AIRPLANE MODEL WITH VARIABLE SWEEPBACK IN THE INCOMPRESSIBLE REGION. PART 1: COMPARISON OF THE MOST IMPORTANT EXPERIMENTAL PARAMETERS AND THEIR INFLUENCE ON THE AERODYNAMIC COEFFICIENTS [WINDKANALUNTERSUCHUNGEN AN EINEM FLUGZEUGMODELL MIT VARIABLEM PFEILUNG IM INKOMPRESSIBLEN BEREICH. TEIL 1: VERGLEICHENDE ZUSAMMENSTELLUNG DER WICHTIGSTEN PARAMETER DER UNTERSUCHUNGSREIHE UND IHRE EINFLUESSE AUF DIE AERODYNAMISCHEN BEIWERTE]

Dieter Schmitt 7 Aug. 1973 146 p refs In GERMAN
 Sponsored by Deut. Forschungsgemeinschaft
 (IFD-4/73-Pt.1) Avail: NTIS HC \$5.75

The influence of variation of wing sweepback, pivot position, horizontal tail surface, angle of attack of the horizontal tail surface, body strake, and sideslip angle on the stationary aerodynamic coefficients of the lateral and longitudinal movement of an aircraft model with variable sweepback was investigated. Photographs of the flow distribution in various planes above the wing were made. The measured neutral point variations of the body-wing configuration as a function of the sweep angle were compared with theoretical calculations. ESRO

N75-17299# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.

TRANSONIC WIND TUNNEL TESTS ON TWO-DIMENSIONAL AEROFOIL SECTIONS PART 1: DETERMINATION OF PRESSURE DISTRIBUTION AND DRAG FOR AN AEROFOIL OF TYPE NLR 13 IN FFA WIND TUNNEL S6

Goeran Ehn Sep. 1974 281 p refs
 (Contract F-INK-81133-71-302(21898))
 (FFA-TN-AU-725-Pt.1) Avail: NTIS HC \$8.75

Wind tunnel tests of a two dimensional airfoil designed for zero lift and supercritical pressure distribution were conducted. Experimental verification of shock-free transonic flow around these quasi-elliptic airfoil sections was obtained. The investigation included airfoil pressure distribution measurements and drag measurements in the Mach number range from 0.5 to 0.85 and for angles of attack from minus 4 degrees to plus 4 degrees. It was determined that at near design conditions the maximum suction on the airfoil was below the predicted value. Variations in drag coefficients were also determined and the causes for the variations are analyzed. Author (ESRO)

N75-17302# Royal Aircraft Establishment, Teddington (England). Aerodynamics Dept.

COMPARISON BETWEEN DYNAMIC STABILITY BOUNDARIES FOR NPL 9615 AND NACA 0012 AEROFOILS PITCHING ABOUT THE QUARTER-CHORD

A. W. Moore, N. C. Lambourne, and L. Woodgate London Aeron. Res. Council 1974 53 p refs Supersedes RAE-TR-71163; ARC-33252 (ARC-CP-1279; RAE-TR-71163; ARC-33252) Avail: NTIS HC \$4.25; HMSO 85 p; PHI \$3.65

The results are presented of stall flutter tests on two airfoils one with NACA 0012 section and the other with NPL 9615 section. A free-oscillation technique is used, each model having a single degree of freedom, namely pure pitching about a quarter-chord axis. Conditions giving zero aerodynamic damping are found for a range of frequency, Mach number, mean incidence and amplitude of oscillation appropriate to a helicopter blade. The results with a smooth leading edge are seen to compare favorably with other tests in which forces were determined by integration of chordwise pressure distributions measured near the center line of a similar airfoil. The main conclusion from these tests, reached after a consideration of the relative positions of the boundaries for negative aerodynamic damping and for maximum lift, is that the improvements that the NPL 9615 section offers in maximum lift can be used with no greater likelihood of stall flutter occurring with this section than with the NACA 0012 section. A further important conclusion relates to the condition of the leading edge. When a roughness strip of carborundum particles is added at the leading edge of each airfoil, instability is encountered at a lower mean incidence than with a smooth surface. Author (ESRO)

N75-17303# Technical Univ. of Denmark, Lyngby.

APPLICATION OF A VARIATIONAL METHOD IN PLANE COMPRESSIBLE FLOW CALCULATION

H. Rasmussen and N. Heys London Aeron. Res. Council 1974 28 p refs Supersedes RAE-TR-72230; ARC-34605 Sponsored by Sci. Res. Council Prepared jointly with Southampton Univ. (ARC-CP-1284; RAE-TR-72230; ARC-34605) Avail: NTIS HC \$3.75; HMSO 50 p; PHI \$2.25

The classical problem of steady inviscid plane subsonic flow past an airfoil is formulated as a variational principle, the Bateman-Dirichlet principle. A finite difference method was used to calculate approximations to the extremals for flow past ellipses and Karman-Trefftz profiles of different thickness ratios. The solutions obtained for the ellipses were compared with other approximate solutions except near the stagnation points where differences of up to 5% are encountered. Author (ESRO)

N75-17304# Royal Aircraft Establishment, Farnborough (England). Structures Dept.

AN AEROELASTIC MODEL HELICOPTER ROTOR

R. Cansdale London Aeron. Res. Council 1974 30 p refs Supersedes RAE-TR-73042; ARC-34836 (ARC-CP-1288; RAE-TR-73042; ARC-34836) Avail: NTIS HC \$3.75; HMSO 55p; PHI \$2.35

The design, construction, and testing of a 1/5 scale model of a non-articulated helicopter main rotor are discussed. The scaling was such as to ensure correct Froude number representation. The measured flap and lag stiffnesses of the model were close to the scaled values, although the frequencies of the fundamental flap and lag modes were lower than the design figure. The higher mode frequencies, however, agreed well with the scaled values. Author (ESRO)

N75-17305# Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.

MEASUREMENT OF THE INTERNAL PERFORMANCE OF A RECTANGULAR AIR INTAKE MOUNTED ON A FUSELAGE AT MACH NUMBERS FROM 1.6 TO 2, PART 4

C.S. Brown and E. L. Goldsmith London Aeron. Res. Council 1974 70 p refs Supersedes RAE-TR-72136; ARC-34333 (ARC-CP-1291; RAE-TR-72136; ARC-34333) Avail: NTIS HC \$4.25; HMSO £1; PHI \$3.90

A rectangular variable geometry intake, whose internal performance in a uniform flow field had previously been measured, was tested on a fuselage with its leading edge both horizontal and vertical. In the case of the vertical intake, the effect of removing the lower swept endwall was investigated. The tests were done in a range of Mach number from 1.61 to 2.01 at incidences from 0 deg to 12 deg. The Reynolds number based on intake entry height was approximately 0.7×10^6 to the sixth power. This particular fuselage appears to impose only a small effect on the intake performance when the intake is horizontal. However a survey of the fuselage flow field indicates the complexity of the flow entering the intake and emphasizes the difficulty in using average flow properties to establish very accurate estimates of mass flow. The vertical intake suffers considerable loss of performance both in terms of maximum mass flow and critical point pressure recovery at incidences above about 4 deg when fitted with swept endwalls. By removing the lower swept endwall, the zero incidence performance can be maintained up to incidences of 12 deg. Author (ESRO)

N75-17306# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

LOW-SPEED WIND-TUNNEL TESTS ON THE LIFT-DEPENDENT DRAG OF DELTA WINGS WITH CONICAL CAMBER

D. L. I. Kirkpatrick and P. J. Butterworth London Aeron. Res. Council 1974 39 p refs Supersedes RAE-TR-72123; ARC-34085 (ARC-CP-1293; RAE-TR-72123; ARC-34085) Avail: NTIS HC \$3.75; HMSO 70p; PHI \$2.95

A theoretical method of designing cambered slender wings to have low lift-dependent drag is described. The results of subsonic wind tunnel tests on a series of thin cambered delta wings of aspect ratio 2 are presented, and the significant drag reductions achieved are discussed in relation to theoretical predictions for the drag of cambered slender wings. Author (ESRO)

N75-17307# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

A PREDICTION METHOD FOR PRESSURE DISTRIBUTIONS ON COMPRESSION SURFACES OF CONICAL BODIES AT SUPERSONIC SPEEDS

M. J. Larcombe London Aeron. Res. Council 1974 28 p refs Supersedes RAE-TM-AERO-1457; ARC-34849 (ARC-CP-1295; RAE-TM-AERO-1457; ARC-34849) Avail: NTIS HC \$3.75; HMSO 50p; PHI \$2.15

An approximation to the flow on the compression surfaces of delta wings and conical bodies was made by a new simple method. Surface pressure distributions were obtained by an interpolation procedure between circularly conical flow and two dimensional flow. The technique is applicable to a wide variety of body geometries and flow conditions including cases with either attached or detached shock waves at the leading edges. Author (ESRO)

N75-17309# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.

ICE SIMULATION: A 2-DIMENSIONAL WIND TUNNEL INVESTIGATION OF A NACA 652A215 WING SECTION WITH SINGLE SLOTTED FLAP. PART 2: CONFIGURATIONS TYPICAL FOR TRANSPORT AIRPLANES

U. Clareus Jun. 1974 32 p refs (Contract SWEDBD-73-4722) (FFA-TN-AU-995-Pt-2) Avail: NTIS HC \$3.75

The effect of simulated ice on the aerodynamic characteristics of a two-dimensional wing section with and without a single slotted flap was investigated. Seven different ice configurations for large transport aircraft were tested using three different flap angles. The results show that the maximum lift coefficient is very sensitive to disturbances on the wing leading edge. The loss in $C(L_{max})$ varies from 10 to 40% for the different configurations tested. The drag coefficient is also adversely affected; in some cases the drag increase amounts to several

hundred percent, with a corresponding reduction in the lift over drag ratio. The relatively low importance of geometrical size of the ice formation, once the first leading edge disturbance is formed, was verified. Author (ESRO)

N75-17310# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.

THE VISCOUS FLOW AROUND A TWO DIMENSIONAL HIGH LIFT WING. ANALYSIS OF BOUNDARY LAYER MEASUREMENTS Final Report

A. Bertelrud and B. L. G. Ljungstroem Oct. 1974 113 p refs (Contract SWEDBDT-73-4381)

(FFA-TN-AU-1155) Avail: NTIS HC \$5.25

The shear layer data for a 2D high lift model is presented in terms of boundary layer integral properties and wake parameters. The high lift model had two basic configurations: small or large slat gap corresponding to different extents of mixing. Slat and wing suction was used to alter the conditions for viscous interaction. Data in the form of tabulated velocity profiles, and data for 56 free wakes obtained in the high pressure gradient flow are presented. Some simple comparisons with theory were made. Development of a complete calculation method is considered to be outside the scope of the present study.

Author (ESRO)

N75-17313# Army Foreign Science and Technology Center, Charlottesville, Va.

A LIMITING CASE OF MULTIPHASE FLOW PAST SLENDER BODIES

Kh. Rakhmatulin and S. I. Meliyudov 27 Aug. 1974 10 p refs Transl. into ENGLISH from Akad. Nauk Uzbekskoi SSR, Tashkent. Izv. Seriya Tekhn. Nauk (USSR), v. 16, no. 6, 1972 p 31-35

(AD-A000240; FSTC-HT-23-369-74) Avail: NTIS CSCL 01/1

The article considers a uniform gas flow containing fine particles of solid material which impinges on a thin symmetrical airfoil. It is shown that to solve the problem of multivelocity flow past slender bodies a relation for the pressure as a function of the mean mixture density derived for single-velocity motion may be employed. GRA

N75-17314# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.

STALL FLUTTER AND NONLINEAR DIVERGENCE OF A TWO-DIMENSIONAL FLAT PLATE WING Final Report

John Dugundji and Krishnaswamy Aravamudan Jul. 1974 67 p refs

(Contract F44620-69-C-0091)

(AD-A000569; ASRL-TR-159-6; AFOSR-74-1734TR) Avail: NTIS CSCL 20/4

An experimental investigation is made of the stall flutter and nonlinear divergence characteristics of a two-dimensional flat-plate wing, pivoted about the mid-chord. The only nonlinearity present was aerodynamic. Measurements were taken of static moments, flutter amplitudes, centershifts, frequencies, and decay-growth rates for various initial angle-of-attack settings, and compared with linear theory and quasistatic theory. Nonlinear divergence was also observed and resulting static equilibrium positions were obtained. Free rotation tests of the wing were also conducted. (Modified author abstract) GRA

N75-17318# Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.

LOW SPEED WIND TUNNEL TEST OF JET FLAPS AND FLOATING WINGTIPAILERONS ON A FIGHTER WING Final Report

John A. Eney and Samuel Greenhaigh 17 Oct. 1974 25 p refs

(ZRO0001)

(AD-A000809; NADC-74198-30) Avail: NTIS CSCL 20/4

An 18% scale semispan fighter wing was tested at low speed in various configurations to assess improvements in lift and roll control. A full span jet flap achieved a CL 14% higher

than current aircraft. Floating wingtip ailerons provided undiminished roll control up through high angles of attack. Parameters measured were angle of attack, lift coefficient, drag coefficient, pitching moment, rolling moment, and yawing moment. GRA

N75-17319# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.

TURBULENT WAKE BEHIND SLENDER BODIES INCLUDING SELF-PROPELLED CONFIGURATIONS Final Report

R. C. Swanson, Jr., J. A. Schetz, and A. K. Jakubowski Sep. 1974 113 p refs

(Contract N00014-72-A-0136-0004; NR Proj. 062-481)

(AD-A001040; VPI-Aero-024) Avail: NTIS CSCL 20/4

The turbulent wakes behind a streamlined drag body, a jet-propelled body, and a propeller-driven body are studied experimentally in a subsonic wind tunnel at a principal nominal free-stream velocity of 208 ft/sec. Mean flow data taken downstream of the sterns of these bodies include velocity and static pressure distributions. The stream-wise variation of the maximum values of axial turbulence intensity and radial shear stress are also presented. The mean flow data for the wake behind the drag body compare favorably with previous experiments and establish a rigid reference for the wakes behind slender, self-propelled configurations. The downstream rate of decay is essentially the same for the drag and propeller-driven bodies, whereas the decay for the jet-propelled body is substantially faster. GRA

N75-17320# Royal Aircraft Establishment, Farnborough (England). Structures Dept.

THE CIVIL AIRCRAFT AIRWORTHINESS DATA RECORDING PROGRAMME. A STUDY OF NORMAL OPERATIONAL LANDING PERFORMANCE ON SUBSONIC CIVIL JET AIRCRAFT

G. B. Hutton London Aeron. Res. Council 1974 56 p refs

Supersedes RAE-TR-72097; ARC-34303; CAADRP-TR-26

(ARC-CP-1273; RAE-TR-72097; ARC-34303; CAADRP-TR-26)

Avail: NTIS HC \$4.25; HMSO 95p; PHI \$3.90

A statistical study was conducted of a number of performance and flying control parameters on two aircraft types during final approach and landing. Approximately 200 landings from each of two periods with a gap of one year were studied on both aircraft types and the results show the probability of meeting or exceeding various values of each parameter together with mean values and standard deviations. Author (ESRO)

N75-17322# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.

AIRCRAFT ACCIDENT REPORTS. BRIEF FORMAT SUPPLEMENTAL ISSUE, 1973 ACCIDENTS. FILE NUMBERS 1-0040 THRU 1-0042, 3-4141 THRU 3-4163, 4-0001 THRU 4-0032, 5-0001 THRU 5-0035, 6-0001 THRU 6-0086, A-0001 THRU A-0003, A-0005, C-0001, E-0001 THRU E-0023

16 Sep. 1974 101 p

(PB-237091/4; NTSB-BA-74-5) Avail: NTIS HC \$5.25 CSCL 01B

Reports of aircraft accidents and incidents that occurred in 1973 are presented. GRA

N75-17325# Mitre Corp., McLean, Va.

STUDY OF ALTERNATIVE BEACON BASED SURVEILLANCE AND DATA LINK SYSTEMS, VOLUME 2 Final Report

S. R. Jones, R. C. Gibbons, A. M. Manders, N. A. Spencer, and I. B. Ylvisaker Apr. 1974 400 p refs

(Contract DOT-FA70WA-2448)

(AD-772136; MTR-6517-Vol-2; FAA-EM-74-7-2) Avail: NTIS HC \$10.25

Several beacon-based surveillance systems--both addressed and non-addressed--as well as several data link systems, in

appropriate combinations, were analyzed with respect to meeting the future requirements of the Upgraded Third Generation ATC System. These requirements included surveillance characteristics suitable for automatic ground-based collision avoidance (IPC); they also included data link characteristics suitable for delivering all ATC and IPC services and estimated company digital communication services. The Discrete Address Beacon System (DABS) is shown to be the lowest cost of all alternatives for implementing IPC for the basic general aviation user. The detailed analytical and engineering design efforts are discussed. Author

N75-17326# Lincoln Lab., Mass. Inst. of Tech., Lexington.
ATC SURVEILLANCE/COMMUNICATION ANALYSIS AND PLANNING Quarterly Technical Summary, 1 Mar. - 31 May 1974

1 Jun. 1974 20 p refs
 (Contracts DOT-FA72WAI-242; F19628-73-C-0002)
 (AD-783184; FAA-RD-74-105) Avail: NTIS HC \$3.00

Under ASR improvement program, several changes to the FPS-18 radar were completed to improve its stability under variable prf conditions. The digital interfaces to the NOVA computer were finalized and put into operation. System tests commenced and demonstrated good aircraft detection when operating on all but the zero-velocity filter. Correction of this problem is under active investigation. NAFEC Support was completed. Precision altitude and landing monitor system tests were conducted. Some initial data were in good agreement with theoretical predictions; some in gross disagreement. Investigation disclosed a problem in two of the five antennas, and this is being corrected. Test results are reported. Author

N75-17327* Research Triangle Inst., Research Triangle Park, N.C. Engineering Div.

AN INVESTIGATION OF ERRORS AND DATA PROCESSING TECHNIQUES FOR AN RF MULTILATERATION SYSTEM
 Charles L. Britt, Jr. Feb. 1975 149 p refs
 (Contract NAS1-12910)
 (NASA-CR-132609; RTI-43U-954) Avail: NTIS HC \$5.75 CSCL 17G

The development of an RF Multilateration system to provide accurate position and velocity measurements during the approach and landing phase of Vertical Takeoff Aircraft operation is discussed. The system uses an angle-modulated ranging signal to provide both range and range rate measurements between an aircraft transponder and multiple ground stations. Range and range rate measurements are converted to coordinate measurements and the coordinate and coordinate rate information is transmitted by an integral data link to the aircraft. Data processing techniques are analyzed to show advantages and disadvantages. Error analyses are provided to permit a comparison of the various techniques. Author

N75-17329# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ADAPTION PROCESSES IN AIRCRAFT GUIDANCE SYSTEMS
 I. S. Ukolov 21 Oct. 1974 30 p refs Transl. into ENGLISH from Akad. Nauk SSSR, Nauchn. Sov. Po Kompleksn. Probl., Inform. Materialy (USSR), v. 6, no. 53, 1972 p 5-19
 (AD-A000354; FTD-HC-23-2731-74) Avail: NTIS HC \$3.75 CSCL 17/7

The principal feature of self-regulating systems and autopilots consists of the fact that, in estimating and analyzing the dynamic characteristics of the aircraft directly during flight, the system reconstructs the contour parameters for guidance in the direction necessary to provide optimal margins of stability and guidance process quality. Particular attention is paid to the problem of developing and producing self-regulating autopilots. The development of theoretical bases and the modification of new principles and methods of guidance are considered. Author

N75-17332# Sperry Rand Corp., Great Neck, N.Y. Sperry Gyroscope Div.
LASER GYRO REACTION TIME INVESTIGATION PROGRAM

Technical Report, 1 Mar. 1973 - 31 Mar. 1974

Robert F. Morrison Sep. 1974 73 p
 (Contract F33615-73-C-1054; AF Proj. 6095)
 (AD-A001646; SGD-4284-0754; AFAL-TR-74-189) Avail: NTIS CSCL 17/7

The underlying purpose of the investigation was to evolve a ring laser gyro design suitable for application in unaided aircraft inertial navigation systems. Significant improvement in laser gyro performance capability was the program goal, to be attained by analyzing and modifying parameters affecting gyro drift and reaction time. In addition to the analytical effort, the work scope included fabrication and testing of an experimental ring laser gyro (RLG) of new design. The prime effort was not directed toward developing new concepts but rather toward improving good available designs by choice of materials, circuit modifications, packaging, etc. The goal of instantaneous operation was demonstrated with a random drift of 0.015 degree/hour after less than a half hour of operation. GRA

N75-17333# Analytic Sciences Corp., Reading, Mass.
AN/ASN-90 SYSTEMS IMPROVEMENT PROGRAM Final Report, Oct. 1972 - Jun. 1974

William K. Sharpley and Robert F. Shipp 31 Oct. 1974 84 p
 (Contract F33615-73-C-1146; AF Proj. 6095)
 (AD-A001647; TASC-353-10; AFAL-TR-74-250) Avail: NTIS CSCL 17/7

Status is reported on the development of tools for the analysis of operational performance and operational maintenance of a complex avionics system, and the cost-of-ownership implications of improvement alternatives. Results of the application of these tools to the AN/ASN-90 Inertial Measurement Set, as used in the A-7D aircraft, are also reported. These results were obtained as part of TASC's continuing participation in the KT-73 Inertial Navigation Systems Technical Interchange Task Group (TITG) chaired by the Air Force Item Manager at the Oklahoma City Air Logistics Center. GRA

N75-17334# Boeing Co., Wichita, Kans.
FAA JT3D QUIET NACELLE RETROFIT FEASIBILITY PROGRAM. VOLUME 3: LOWER GOAL FLIGHT TESTING, ECONOMIC ANALYSES AND SUMMARY Final Report, Jul. 1971 - Nov. 1973

J. E. Mayer et al Feb. 1974 378 p refs
 (Contract DOT-FA71WA-2628)
 (AD-787610; D3-9042-4; FAA-RD-73-131-Vol-3) Avail: NTIS HC \$10.50

A program to design and flight test quiet nacelles suitable for installation on Boeing 747 aircraft with JT3D turbofan engines was conducted. The purpose of the program was to provide data to assist in determining whether the current Boeing 707 aircraft fleet can be modified for meaningful noise reductions. The modifications to the nacelles are described. The flight test program is discussed and the performance of the modified nacelle is compared with the baseline configuration. An economic analysis of retrofitting the Boeing 707 aircraft fleet with production configuration quiet nacelles is included. Author

N75-17335* Kanner (Leo) Associates, Redwood City, Calif.
THE SIGNIFICANCE OF AERODYNAMIC JET INTERFERENCE IN DEVELOPMENT AND TESTING OF THE Do 31 V/STOL TRANSPORT

D. Welte Washington NASA Feb. 1974 25 p refs Transl. into ENGLISH from Deut. Ges. fur Luft-und Raumfahrt, Jahrestagung, 5th (Berlin) Paper 72-106, 4-6 Oct. 1972
 (Contract NASw-2481)
 (NASA-TT-F-16165; Paper-72-106) Avail: NTIS HC \$3.25 CSCL 01C

Model measurements performed in the wind tunnel indicated a 3.5% lift loss during hover, increasing to 7 or 8% close to the ground. During transition, the jet-induced, tail-heavy moment demanded a large part of available trimming moment. A series of VTOL transitions flown by the Do 31 E3 test aircraft has been analyzed with regard to jet-induced forces and moments. Agreement between model and flight measurements is satisfactory, supporting the model engineering and model laws. A

familiar, simple, semiempirical method for calculating jet-induced normal force during hover is extended to complex configurations such as that of the Do 31. Author

N75-17336* Lockheed-California Co., Burbank.
STUDY OF ACTIVE COOLING FOR SUPERSONIC TRANSPORTS Final Report

G. D. Brewer and R. E. Morris Feb. 1975 152 p refs
 (Contract NAS1-13226)
 (NASA-CR-132573) Avail: NTIS HC \$6.25 CSCL 01C

The potential benefits of using the fuel heat sink of hydrogen fueled supersonic transports for cooling large portions of the aircraft wing and fuselage are examined. The heat transfer would be accomplished by using an intermediate fluid such as an ethylene glycol-water solution. Some of the advantages of the system are: (1) reduced costs by using aluminum in place of titanium, (2) reduced cabin heat loads, and (3) more favorable environmental conditions for the aircraft systems. A liquid hydrogen fueled, Mach 2.7 supersonic transport aircraft design was used for the reference uncooled vehicle. The cooled aircraft designs were analyzed to determine their heat sink capability, the extent and location of feasible cooled surfaces, and the coolant passage size and spacing. Author

N75-17337* Royal Aircraft Establishment, Farnborough (England).

THE USE OF TITANIUM AND ITS ALLOYS IN THE MANUFACTURE OF HELICOPTERS AND AIRCRAFT STRUCTURES

A. Bourgeois and G. Sertour Nov. 1974 22 p Transl. into ENGLISH from Revue de Metallurgie (Paris), v. 71, no. 1, Nov. 1974 p 87-98
 (BR44857; RAE-Lib-Trans-1816) Avail: NTIS HC \$3.25

The important properties of titanium alloys are summarized and the specific properties of these alloys are compared with those of steels and aluminum alloys. The fatigue strength, the resistance to crack propagation and the stress corrosion behaviour of titanium alloys are discussed. Examples of titanium alloy structural components are given and the importance of titanium alloy fasteners is demonstrated. The use of titanium alloy stiffened structures is also noted, and attention is drawn to new products such as titanium alloy castings and extrusions, hydraulic tubing, and creep formed components. Author

N75-17338* Virginia Univ., Charlottesville. Dept. of Engineering and Applied Science.

PRELIMINARY RIDE-QUALITY EVALUATION OF THE HM.2 HOVERFERRY

Eugene W. McClurken, Jr., I. D. Jacobson, and A. R. Kuhlthau Dec. 1974 11 p refs
 (Grant NGR-47-005-181)
 (NASA-CR-142290; Memo-403216) Avail: NTIS HC \$3.25 CSCL 01B

The results of a forty-minute exposure of the HM.2 Hoverferry are presented. Quantitative evaluations were made from aft seats on the starboard side for a sea state considered calm and visually estimated at one-half to one foot. Since this type of craft is sensitive to sea state, the conclusions are based on ideal conditions. Some drawings are included. Author

N75-17339* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

FUTURE LONG-RANGE TRANSPORTS: PROSPECTS FOR IMPROVED FUEL EFFICIENCY

A. L. Nagel, W. J. Alford, Jr., and J. F. Dugan, Jr. Feb. 1975 19 p refs
 (NASA-TM-X-72659) Avail: NTIS HC \$3.25 CSCL 01C

A status report is provided on current thinking concerning potential improvements in fuel efficiency and possible alternate fuels. Topics reviewed are: (1) historical trends in airplane efficiency; (2) technological opportunities including supercritical aerodynamics, (3) vortex diffusers, (4) composite materials, (5) propulsion systems, (6) active controls, and terminal-area operations; (7) unconventional design concepts, and (8) hydrogen-fueled airplane. Author

N75-17340* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

FLIGHT TEST INVESTIGATION OF THE VORTEX WAKE CHARACTERISTICS BEHIND A BOEING 727 DURING TWO-SEGMENT AND NORMAL ILS APPROACHES (A JOINT NASA/FAA REPORT)

M. R. Barber, R. L. Kurkowski, L. J. Garodz, G. H. Robinson, H. J. Smith, R. A. Jacobsen, G. W. Stinnett, Jr., T. C. McMurty, J. J. Tymczyszyn, R. L. Devereaux et al Jan. 1975 136 p refs
 (NASA-TM-X-62398; FAA-NA-75-151) Avail: NTIS HC \$5.75 CSCL 01C

Flight tests were performed to evaluate the vortex wake characteristics of a Boeing 727 aircraft during conventional and two-segment instrument landing approaches. Smoke generators were used for vortex marking. The vortex was intentionally intercepted by a Lear Jet and a Piper Comanche aircraft. The vortex location during landing approach was measured using a system of phototheodolites. The tests showed that at a given separation distance there are no readily apparent differences in the upsets resulting from deliberate vortex encounters during the two types of approaches. The effect of the aircraft configuration on the extent and severity of the vortices is discussed. Author

N75-17341* Clemson Univ., S.C. Dept. of Mechanical Engineering.

A CURVE FITTING METHOD FOR SOLVING THE FLUTTER EQUATION M.S. Thesis

Jerry Lynn Cooper Dec. 1972 118 p refs
 (Grant NGR-41-001-027)
 (NASA-CR-132629) Avail: NTIS HC \$5.25 CSCL 01C

A curve fitting approach was developed to solve the flutter equation for the critical flutter velocity. The psi versus nu curves are approximated by cubic and quadratic equations. The curve fitting technique utilized the first and second derivatives of psi with respect to nu. The method was tested for two structures, one structure being six times the total mass of the other structure. The algorithm never showed any tendency to diverge from the solution. The average time for the computation of a flutter velocity was 3.91 seconds on an IBM Model 50 computer for an accuracy of five per cent. For values of nu close to the critical root of the flutter equation the algorithm converged on the first attempt. The maximum number of iterations for convergence to the critical flutter velocity was five with an assumed value of nu relatively distant from the actual crossover. Author

N75-17342* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LANDING IMPACT STUDIES OF A 0.3-SCALE MODEL AIR CUSHION LANDING SYSTEM FOR A NAVY FIGHTER AIRPLANE

Trafford J. W. Leland and William C. Thompson Washington Mar. 1975 37 p refs
 (NASA-TN-D-7875; L-9978) Avail: NTIS HC \$3.75 CSCL 01C

An experimental study was conducted in order to determine the landing-impact behavior of a 0.3-scale, dynamically (but not physically) similar model of a high-density Navy fighter equipped with an air cushion landing system. The model was tested over a range of landing contact attitudes at high forward speeds and sink rates on a specialized test fixture at the Langley aircraft landing loads and traction facility. The investigation indicated that vertical acceleration at landing impact was highly dependent on the pitch angle at ground contact, the higher acceleration of approximately 5g occurring near zero body-pitch attitude. A limited number of low-speed taxi tests were made in order to determine model stability characteristics. The model was found to have good pitch-damping characteristics but stability in roll was marginal. Author

N75-17344* Grumman Aerospace Corp., Bethpage, N.Y.

SIMULATION OF HYPERSONIC SCRAMJET EXHAUST Final Report

R. A. Oman, K. M. Foreman, J. Leng, and H. B. Hopkins Washington NASA Mar. 1975 72 p refs
 (Contract NAS1-12553)

(NASA-CR-2494) Avail: NTIS HC \$4.25 CSCL 21E

A plan and some preliminary analysis for the accurate simulation of pressure distributions on the afterbody/nozzle portions of a hypersonic scramjet vehicle are described. The objectives fulfilled were to establish the standards of similitude for a hydrogen/air scramjet exhaust interacting with a vehicle afterbody, determine an experimental technique for validation of the procedures that will be used in conventional wind tunnel facilities, suggest a program of experiments for proof of the concept, and explore any unresolved problems in the proposed simulation procedures. It is shown that true enthalpy, Reynolds number, and nearly exact chemistry can be provided in the exhaust flow for the flight regime from Mach 4 to 10 by a detonation tube simulation. A detailed discussion of the required similarity parameters leads to the conclusion that substitute gases can be used as the simulated exhaust gas in a wind tunnel to achieve the correct interaction forces and moments. Author

N75-17345# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

SURFACE EFFECT TAKEOFF AND LANDING SYSTEM (SETOLS) Program Report, 1969 - 1973

Elmer T. Burgan and Fletcher C. Paddison Apr. 1974 47 p refs
(ARPA Order 798)

(AD-A000101; ARPA-TIO-74-21) Avail: NTIS CSCL 01/2

An ARPA Program Report on its program to develop the surface effect takeoff and land system (SETOLS) for high performance naval carrier-based aircraft. The report discusses the program's back-ground and technical need, the detailed plan to develop and demonstrate the technique, the program results allocated resource levels, the contractor's performance and the program's impact. Author (GRA)

N75-17346# Lockheed-Georgia Co., Marietta.

APPLICATION OF THE EQUIVALENT MECHANICAL FLAP CONCEPT TO JET FLAPPED WING-BODY COMBINATIONS Final Technical Report, May - Dec. 1973

A. E. Holmes, Lane Barnett, and Willi F. Jacobs Nov. 1974 155 p refs
(Contract F33615-73-C-4142; AF Proj. 7071)
(AD-A000431; LG74ER0115; ARL-74-0136) Avail: NTIS CSCL 01/1

The analysis of powered lifting systems of the jet flap type requires an accounting of the mutual aerodynamic interference between the airframe (hard boundary) and the jet efflux (soft boundary). The development of a very generalized analysis technique is hardly feasible. However, the Externally Blown Flap (EBF), Upper Surface Blowing (USB), Internally Blown Flap (IBF), and the Augmentor wing (AW) constitute a family of powered lifting systems which are reducible to a common overall aerodynamic concept, but which differ primarily in their mechanical implementation and secondarily in aerodynamic detail. This report presents a relatively simple technique based on careful application of linearized theory. The method applies to the analogous systems mentioned above. The comparison of theoretical results with experimental data shows that the method is sufficiently accurate to be very useful in practice. GRA

N75-17347# Instrument Flight Center, Randolph AFB, Tex.
HELICOPTER TERPS VALIDATION STUDY, PHASE 1 Final Report

William E. Clark, Jr. and Gabriel P. Intano Oct. 1974 92 p (AD-A000423; IFC-TR-74-4) Avail: NTIS CSCL 01/2

With the addition of Chapter 11 to AFM 55-9, an attempt was made to provide helicopters with specialized approach criteria. Chapter 11 criteria was written largely from opinion with little feasibility testing accomplished. Helicopter TERPs Validation Study, Phase I, was conducted in order to provide Chapter 11 criteria validation. Eight highly qualified Air Force Instructor Pilots (with varied helicopter experience) were utilized as subject pilots. Each subject flew five different approaches utilizing maximum descent gradients, utilizing minimum segment lengths for maximum intercept angles, and maneuvering at minimum

distance from the facility. Included were VOR, TACAN and ILS type approaches. All approaches were flown at 90 knots. (Modified author abstract) GRA

N75-17348# General Dynamics/Convair, San Diego, Calif. Aerospace Div.

WEAPON SYSTEM COSTING METHODOLOGY FOR AIRCRAFT AIRFRAMES AND BASIC STRUCTURES. VOLUME 3: COST DATA BASE Interim Report, Jul. 1972 - Nov. 1973

R. E. Kenyon Jun. 1974 157 p ref
(Contract F33615-72-C-2083; AF Proj. 1368)
(AD-A000399; CASD-AFS-73-001; AFFDL-TR-73-129-Vol-3) Avail: NTIS CSCL 01/3

This volume presents the cost data used as the basis for developing the trade cost estimating technique for aerodynamic surfaces. Other data that has become available in the course of the study is also presented. Raw data and organized data are presented. An ultimate objective of the study with respect to the cost data base is to present back-up data for each individual CER, including both trade study and system costing relationships. The cost trend data that is included was produced under an amendment to the contract. Its intent was to provide a data base for cost estimate evaluation. Author (GRA)

N75-17349# Kaman Aerospace Corp., Bloomfield, Conn.

MECHANICAL INSTABILITY GROUND DYNAMICS PROGRAM Final Report

Ross F. Metzger Mar. 1974 61 p refs
(Contract N00019-73-C-0460)

(AD-A001101; R-1249) Avail: NTIS CSCL 01/3

A state-of-the-art survey has been performed to determine if any work has been performed which associates soil dynamics with mechanical instability in helicopters. None was found. No data pertaining to the range of near surface soil dynamic properties were found. A method of determining the mechanical stability of a helicopter in contact with the soil has been developed. A parametric study has been performed to examine the UH2 helicopter under conditions of a range soil properties. It was found that there are ranges of parameters which will cause mechanical instability. It is recommended that a program be initiated to obtain quantitative near surface dynamic characteristics of representative soils through field testing. GRA

N75-17350# School of Aerospace Medicine, Brooks AFB, Tex.
PROPOSED WINDSHIELD FOR B-1 AIRCRAFT: AN OPTICAL EVALUATION Final Report, 1 May - 1 Sep. 1972

Wayne F. Provines, Benjamin Kislin, and Thomas J. Tredici Sep. 1974 12 p refs
(AF Proj. 7755)

(AD-A001078; SAM-TR-74-35) Avail: NTIS CSCL 01/3

A square sample segment, 25.4- by 25.4-cm (10- by 10-in.), representative of the B-1 aircraft proposed windshield was evaluated to determine if Air Force optical specifications would be met in the state-of-the-art production. The 3.53-cm-thick (1.39-in.) five-layer laminant segment was composed of acrylic, silicone, polycarbonate, silicone, and polycarbonate layers, respectively. Light transmission was 66% in normal position and 54% when sloped to the corresponding installed angle (65 degrees from normal). Deviation values, measured directly by displacement of a HeNe laser beam, varied from 0 to 7 min of arc when measured over the entire segment. A distortion map plotted at 2.54-cm (1-in.) intervals showed as much as a 3-min arc change per 2.54 cm. The haze value was 2.95%. GRA

N75-17351# Human Engineering Labs., Aberdeen Proving Ground, Md.

US ARMY HUMAN ENGINEERING LABORATORY HELICOPTER COCKPIT LIGHTING STUDY. PHASE 1: AN EVALUATION OF CURRENT AND POTENTIAL INSTRUMENT PANEL LIGHTING TECHNIQUES FOR USE IN ARMY HELICOPTERS

Harry R. Stowell and Alan M. Poston Aug. 1974 43 p refs (AD-A001527; HEL-TN-7-74) Avail: NTIS CSCL 01/3

The objective of the study is to evolve lighting specifications which will alleviate current cockpit lighting problems. The objective of this phase was to quantitatively identify the problems with current lighting systems in Army helicopters. It also investigated the potential improvements afforded by some of the state-of-art lighting techniques. Luminance measurements were made at various points on instrument dial faces. Results are shown in tabular and pictorial forms. The results also showed that the current techniques of post and eyebrow lighting are unacceptable. From a comparison of all the techniques examined, the circular wedge technique gave the best light distribution. Illuminance measurements were made at the pilots' eye positions for use in other phases of the lighting study. GRA

N75-17352# National Aeronautical Establishment, Ottawa (Ontario).

RESULTS OF INTERCOMPARISON FLIGHTS BETWEEN THE NAE-T-33 AND THE NCAR BUFFALO ATMOSPHERIC RESEARCH AIRCRAFT

J. I. MacPherson Jul. 1974 36 p refs (AD-A001436; NRC-LR-577; NRC-14239) Avail: NTIS CSCL 01/3

Recent international atmospheric research programs such as BOMEX and IFYGL have been of such a large scale that several aircraft are required to collect data, which, when combined with radiosonde and surface measurements, ultimately form a large internationally-accessible data bank. A fundamental part of the program should be an intercomparison between the measuring aircraft. This report presents results of two such intercomparison flights between the NAE T-33 and NCAR Buffalo atmospheric research aircraft, with the NCAR Sabreliner providing additional data on one of the flights. Data from these flights, which were flown at different altitudes on two days with quite different atmospheric conditions, show generally good agreement, particularly for mesoscale meteorological parameters averaged over the length of a run. Spectra of microscale variables including true gust velocity, heat and momentum flux are compared over a frequency band common to both aircraft. The spectra for longitudinal gusts and temperature fluctuations show excellent agreement between the aircraft, but discrepancies are apparent in the Buffalo vertical gust spectra and resultant fluxes during these flights. GRA

N75-17353*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

INSTRUMENTATION AND CONTROL SYSTEM FOR AN F-15 STALL/SPIN

Felix L. Pitts, David C. E. Holmes, and Klaus P. Zaepfel Dec. 1974 74 p (NASA-TM-X-72647) Avail: NTIS HC \$4.25 CSCL 01D

An instrumentation and control system is described that was used for radio-controlled F-15 airplane model stall/spin research at the NASA-Langley Research Center. This stall/spin research technique, using scale model aircraft, provides information on the post-stall and spin-entry characteristics of full-scale aircraft. The instrumentation described provides measurements of flight parameters such as angle of attack and sideslip, airspeed, control-surface position, and three-axis rotation rates; these data are recorded on an onboard magnetic tape recorder. The proportional radio control system, which utilizes analog potentiometric signals generated from ground-based pilot inputs, and the ground-based system used in the flight operation are also described. Author

N75-17354# Boeing Aerospace Co., Seattle, Wash.
A PROCEDURE FOR THE DESIGN OF MULTIFUNCTION SWITCHING CONTROLS

David K. Graham Aug. 1974 143 p refs (Contract N00014-72-C-0191; NR Proj. 213-088) (AD-A000532; D180-15335-2; JANAIR-740702) Avail: NTIS CSCL 01/4

The handbook provides an independently usable, step-by-step procedure for the design of a multifunction switching control (MSC). An MSC is a matrix of switches which address a computer or other logic interface. This interface, in turn, addresses the system or subsystem to be controlled. Each switch in the matrix may have any number of different functions, its function at any given time determined by system state variables and the programming of the logic interface. The procedure itself is designed to effect the optimum trade between the number of switching controls required and associated operator workload. A conceptual design is developed first, based solely on system (and operator) requirements, to permit a quantitatively assessment of the effect of hardware constraints on the optimum design. Implementation constraints are subsequently introduced and methods of dealing with such constraints described. (Modified author abstract)

GRA

N75-17356# Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.

STATISTICAL REVIEW OF COUNTING ACCELEROMETER DATA FOR NAVY AND MARINE FLEET AIRCRAFT

Semiannual Summary Report, 1 Jan. 1962 - 30 Jun. 1974
Thomas A. DeFiore 1 Nov. 1974 137 p refs (AD-A000092; NADC-13920-2) Avail: NTIS CSCL 01/3

This report is a specialized summary of normal acceleration data recorded by counting accelerometers. Data are separated by calendar time and mission category. Only data reported in the counting accelerometer program are included. Author (GRA)

N75-17357# Boeing Co., Wichita, Kans.

FAA JT3D QUIET NACELLE RETROFIT FEASIBILITY PROGRAM. VOLUME 4: COMPATIBILITY ANALYSIS AND DESIGN STUDY FOR DC-8 AIRCRAFT Final Report, Aug. 1972 - Mar. 1973

Nov. 1973 87 p refs Prepared in cooperation with Douglas Aircraft Co., Long Beach, Calif. (Contract DOT-FA71-WA-2628) (AD-783187; FAA-RD-73-131-Vol-4; D3-9042-5) Avail: NTIS HC \$4.00

Design study is presented of the possible application of the Boeing JT3D quiet nacelle to the current DC-8 short duct and long duct domestic aircraft fleet as exemplified by the DC-8-61 and DC-8-63 aircraft. The study identified many physical and functional problems associated with the use of the Boeing quiet nacelle on DC-8 aircraft. Of the configurations studied, two configurations for the DC-8-61 and two configurations for the DC-8-63 were selected for cost evaluation. The configurations selected for each of the two DC-8 models were identified as Family 1 and Family 2. The Douglas discrete configurations, identified as Family 3, were also studied. Family 3 configurations utilize existing aircraft components to the greatest possible extent but do not emphasize 707/DC-8 fleet commonality. Thus each family represents an approach to acoustically treating both the short duct and long duct fleets of JT3D powered DC-8 aircraft. Also included is an abbreviated comparative cost analysis of all three families (seven configurations total) to determine which nacelle configurations, if retrofitted, would result in the least overall cost. Author

N75-17359# National Aerospace Lab., Tokyo (Japan).

PRELIMINARY EXPERIMENTS ON FILM COOLING OF TURBINE BLADES WITH INJECTION NEAR THE LEADING EDGE. 1: INJECTION THROUGH HOLES LOCATED NEAR THE LEADING EDGE

Makoto Sasaki, Kitao Takahara, and Takao Kumagai 1974 22 p In JAPANESE; ENGLISH summary (NAL-TR-371) Avail: NTIS HC \$3.25

Experiments were made on film cooling with injection through holes located near the leading edge of a model in a low-speed, room-temperature wind tunnel. The model, which simulates the leading edge portion of an air-cooled turbine blade section, consists of a semicircular cylinder with four rows of blowing holes and two flat plates forming the upper and lower surfaces of its body.

The change of flow coefficient of the blowing holes, the pressure distributions, and the temperature distributions (film cooling effectiveness) along the surface of several models were measured. It is shown that the inclination of the blowing holes in the spanwise direction shows very high effectiveness, but that excessive injection sometimes lowers the effectiveness. The film cooling effectiveness of the experimental model and of an air-cooled turbine nozzle are calculated by means of an approximate method. Author

N75-17360* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
NOISE REDUCTION STUDIES FOR THE U-10 AIRPLANE
 David A. Hilton, Andrew B. Connor, Harvey H. Hubbard, and Richard C. Dingeldein Apr. 1975 68 p refs
 (NASA-TM-X-72640) Avail: NTIS HC \$4.25 CSCL 01C

A study was undertaken by the NASA Langley Research Center to determine the noise reduction potential of the U-10 airplane in order to reduce its aural detection distance. Static and flyover noise measurements were made to document the basic airplane noise signature. Two modifications to the airplane configuration are suggested as having the best potential for substantially reducing aural detection distance with small penalty to airplane performance or stability and control. These modifications include changing the present 3-blade propeller to a 5-blade propeller, changing the propeller diameter, and changing the propeller gear ratio, along with the use of an engine exhaust muffler. The aural detection distance corresponding to normal cruising flight at an altitude of 1,000 ft over grassy terrain is reduced from 28,000 ft (5.3 miles) to about 50 percent of that value for modification 1, and to about 25 percent for modification 2. For the aircraft operating at an altitude of 300 ft, the analysis indicates that relatively straightforward modifications could reduce the aural detection distance to approximately 0.9 mile. Operation of the aircraft at greatly reduced engine speed (1650 rpm) with a 1.3-cu-ft muffler provides aural detection distances slightly lower than modification 1. Author

N75-17361* KLD Associates, Inc., Huntington, N.Y.
BROADBAND NOISE GENERATED BY TURBULENT INFLOW TO ROTOR OR STATOR BLADES IN AN ANNULAR DUCT Final Report
 Frank Lnae Washington NASA Mar. 1975 50 p refs
 (Contract NAS1-10309)
 (NASA-CR-2503; TR-4) Avail: NTIS HC \$3.75 CSCL 20A

The Green's function relating the radiated pressure field to the fluctuating forces on rotor or stator blades is developed in the presence of dissipation due to turbulent velocity fluctuations and sound speed fluctuations. The resonances in the output power spectrum which would occur at the cut-off frequencies in the absence of dissipation should be removed and smeared out by the incorporation of dissipation. Wave number dependence is developed for an effective eddy viscosity due to the aforementioned fluctuations in the background medium. The space-time correlation function for blade-normal velocity fluctuations on a single or on two different blades is developed in terms of the velocity correlation tensor for the inflow under the assumptions of isotropy and (Taylor) frozen behavior. The correlation function is then simplified under certain approximations and the behavior of the blade-force correlation function is inferred. Author

N75-17362* Advanced Technology Labs., Inc., Westbury, N.Y.
PREVAPORIZATION AND PREMIXING TO OBTAIN LOW OXIDES OF NITROGEN IN GAS TURBINE COMBUSTORS
 Final Report
 Gerald Roffe and Antonio Ferri Washington NASA Mar. 1975 56 p refs
 (Contract NAS3-17865)
 (NASA-CR-2495; ATL-TR-203) Avail: NTIS HC \$4.25 CSCL 21E

Tests were conducted to determine the effectiveness of prevaporization and premixing in reducing the formation of oxides of nitrogen in a gas turbine type combustor using liquid JP-5 fuel at the supersonic cruise condition. The combustor inlet

temperature was 833 K (1500 R) at a pressure of 4 atmospheres and a reference velocity of 46 m/sec (150 ft/sec). An order of magnitude reduction in nitric oxide emissions was achieved. Nitric oxide emission indices as low as 0.6 gm NO₂/kg fuel were measured at an equivalence ratio of 0.29 with one percent combustion inefficiency without vitiation of the mixer stream.

Author

N75-17363* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DESIGN OF A VERY-LOW-BLEED MACH 2.5 MIXED-COMPRESSION INLET WITH 45 PERCENT INTERNAL CONTRACTION

Joseph F. Wasserbauer, Robert J. Shaw, and Harvey E. Neumann Washington Mar. 1975 71 p refs
 (NASA-TM-X-3135; E-8098) Avail: NTIS HC \$4.25 CSCL 21A

A full-scale, mixed-compression inlet was designed for operation with the TF30-P-3 turbofan engine and tested at Mach numbers of 2.5 and 2.0. The two-cone axisymmetric inlet had minimum internal contraction consistent with high total pressure recovery and low cowl drag. At Mach 2.5, inlet recovery was 0.906 with only 0.021 centerbody bleed mass-flow ratio and no cowl bleed. Increased centerbody bleed gave a maximum inlet unstart angle of attack of 6.85 deg. At Mach 2.0, inlet recovery was 0.94 with only 0.014 centerbody bleed mass-flow ratio and no cowl bleed. Inlet performance and angle-of-attack tolerance is presented for operation at Mach numbers of 2.5 and 2.0. Author

N75-17364* Royal Aircraft Establishment, Farnborough (England). Engineering Physics Dept.

STUDY OF SOLID STATE REMOTE CONTROL TECHNIQUES AS APPLIED TO THE REDESIGN OF THE ELECTRICAL SYSTEM IN A LARGE CIVIL AIRCRAFT

L. V. C. Jones London Aeron. Res. Council 1974 64 p refs
 Supersedes RAE-TR-72238; ARC-34764
 (ARC-CP-1289; RAE-TR-72238; ARC-34764) Avail: NTIS HC \$4.25; HMSO £1; PHI 43.90

A description is given of how the electrical power distribution system of a large civil aircraft might be redesigned to employ remote power controllers, embodying solid state protection, in conjunction with solid state logic, to operate circuits remotely through lightweight signal wires. An assessment of the masses of a conventional and a remotely controlled system, based on a VC-10 aircraft installation in which it is assumed that the latest lightweight cables and switchgear are used indicates that the remotely controlled system would be about 90kg lighter. Additional saving might result from equipment specifically designed to be compatible with solid state remote control techniques. The effect on both systems of resiting the electrical compartment from the forward to a mid-aircraft position has been examined and it is concluded that a further saving of 36 kg would result with remote control. The redesigned system lends itself to, and has been arranged for, easy conversion to multiplexed data transmission. Although a multiplexed system was not assessed, the mass of cables and fittings that would be replaced has been evaluated as 42 kg, or 77 kg if analog circuits were included. Author (ESRO)

N75-17365* Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SOME QUESTIONS ON THE CREATION OF AN OPEN STAND FOR ACOUSTIC INVESTIGATIONS OF DTRD'S

A. I. Balmakov and V. G. Enenkov 22 Oct. 1974 25 p refs
 Transl. into ENGLISH from Tr. Rzhskii Inst. Inzh. Gradzhanskoi Aviat. (Riga), no. 174, 1971 p 135-152
 (AD-A000660; FTD-MT-24-863-74) Avail: NTIS CSCL 21/5

Contemporary methods of experimental research on the acoustic characteristics of DTRD's are examined in the article. Primary attention is given to the full-scale experiment on an open stand. The purposes of acoustic investigations on DTRD's and the basic requirements for test conditions and open stand instrumentation and equipment are set forth. Two versions of

the structural solution of the stand are described: stationary and movable. Basic information about the necessary open stand instrumentation and equipment is given. Author (GRA)

N75-17368* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

MONTE CARLO ANALYSIS OF INACCURACIES IN ESTIMATED AIRCRAFT PARAMETERS CAUSED BY UNMODELED FLIGHT INSTRUMENTATION ERRORS

Ward F. Hodge and Wayne H. Bryant Washington Feb. 1975 36 p refs
(NASA-TN-D-7712; L-9411) Avail: NTIS HC \$3.75 CSCL 01A

An output error estimation algorithm was used to evaluate the effects of both static and dynamic instrumentation errors on the estimation of aircraft stability and control parameters. A Monte Carlo error analysis, using simulated cruise flight data, was performed for a high-performance military aircraft, a large commercial transport, and a small general aviation aircraft. The results indicate that unmodeled instrumentation errors can cause inaccuracies in the estimated parameters which are comparable to their nominal values. However, the corresponding perturbations to the estimated output response trajectories and characteristics equation pole locations appear to be relatively small. Control input errors and dynamic lags were found to be in the most significant of the error sources evaluated. Author

N75-17370* Systems Control, Inc., Palo Alto, Calif.
INPUT DESIGN FOR IDENTIFICATION OF AIRCRAFT STABILITY AND CONTROL DERIVATIVES Final Report

Narendra K. Gupta and W. Earl Hall, Jr. Washington NASA Feb. 1975 134 p refs
(Contract NAS4-2068)
(NASA-CR-2493; H-864) Avail: NTIS HC \$5.75 CSCL 01C

An approach for designing inputs to identify stability and control derivatives from flight test data is presented. This approach is based on finding inputs which provide the maximum possible accuracy of derivative estimates. Two techniques of input specification are implemented for this objective - a time domain technique and a frequency domain technique. The time domain technique gives the control input time history and can be used for any allowable duration of test maneuver, including those where data lengths can only be of short duration. The frequency domain technique specifies the input frequency spectrum, and is best applied for tests where extended data lengths, much longer than the time constants of the modes of interest, are possible. These techniques are used to design inputs to identify parameters in longitudinal and lateral linear models of conventional aircraft. The constraints of aircraft response limits, such as on structural loads, are realized indirectly through a total energy constraint on the input. Tests with simulated data and theoretical predictions show that the new approaches give input signals which can provide more accurate parameter estimates than can conventional inputs of the same total energy. Results obtained indicate that the approach has been brought to the point where it should be used on flight tests for further evaluation. Author

N75-17371* Systems Technology, Inc., Hawthorne, Calif.
FLIGHT CONTROL SYSTEMS PROPERTIES AND PROBLEMS, VOLUME 1 Final Report

Duane T. McRuer and Donald E. Johnston Washington NASA Feb. 1975 169 p refs
(Contract NAS4-1881)
(NASA-CR-2500; TR-1018-1-Vol-1) Avail: NTIS HC \$6.25 CSCL 01C

This volume contains a delineation of fundamental and mechanization-specific flight control characteristics and problems gleaned from many sources and spanning a period of over two decades. It is organized to present and discuss first some fundamental, generic problems of closed-loop flight control systems involving numerator characteristics (quadratic dipoles, non-minimum phase roots, and intentionally introduced zeros).

Next the principal elements of the largely mechanical primary flight control system are reviewed with particular emphasis on the influence of nonlinearities. The characteristics and problems of augmentation (damping, stability, and feel) system mechanizations are then dealt with. The particular idiosyncrasies of automatic control actuation and command augmentation schemes are stressed, because they constitute the major interfaces with the primary flight control system and an often highly variable vehicle response. Author

N75-17372* Systems Technology, Inc., Hawthorne, Calif.
FLIGHT CONTROL SYSTEMS PROPERTIES AND PROBLEMS, VOLUME 2: BLOCK DIAGRAM COMPENDIUM Final Report

Donald E. Johnston Washington NASA Feb. 1975 148 p refs
(Contract NAS4-1881)
(NASA-CR-2501; TR-1018-1-Vol-2) Avail: NTIS HC \$5.75 CSCL 01C

A compendium of stability augmentation system and autopilot block diagrams is presented. Descriptive materials for 48 different types of aircraft systems are provided. A broad representation of the many mechanical approaches which have been used for aircraft control is developed. Author

N75-17373* Royal Aircraft Establishment, Farnborough (England). Structures Dept.

GUST LOADS ON 707 AND VC 10 AIRCRAFT

I. W. Kaynes London Aeron. Res. Council 1974 35 p refs
Supersedes RAE-TR-72156; ARC-34510
(ARC-CP-1281; RAE-TR-72156; ARC-34510) Avail: NTIS HC \$3.75; HMSO 60p; PHI \$2.55

Counting accelerometers were used to record the center of gravity normal accelerations on 707 and VC 10 aircraft during passenger services covering 1,870,000 km and 1,700,000 km respectively. A significant difference was found between the frequency of loads on two nominally identical 707 aircraft, and the relationship of this to differences in autopilot characteristics is discussed. The most severe loads encountered by each aircraft are described. Author (ESRO)

N75-17374* National Aerospace Lab., Amsterdam (Netherlands).
EVALUATION OF THE EFFECT OF A YAW-RATE DAMPER ON THE LATERAL-DIRECTIONAL STABILITY AND CONTROL OF THE BEECHCRAFT QUEEN AIR 80 LABORATORY AIRCRAFT

L. J. Erkelens and C. F. G. M. Hofman 16 Nov. 1973 39 p refs
(NLR-TR-73105-U) Avail: NTIS HC \$3.75

A series of flight tests were conducted with a Beechcraft Queen Air 80 aircraft to evaluate the effect of a simple yaw-rate damper on the lateral-directional stability and control characteristics. The flight tests were carried out after results of a stability analysis and analog simulation of a yaw-rate damper system were available. Responses of the following disturbances and excitations were recorded: (1) rudder kicks, (2) aileron steps, (3) aileron forcing function, and (4) atmospheric turbulence. Several instrument landing approaches in moderate turbulence were made with the yaw-rate damper alternately engaged and disengaged. The influence of engine failure recovery and aircraft stall behavior were investigated. Results are presented in the form of time histories, power spectra, and root-mean-square intensities. Author (ESRO)

N75-17375* Douglas Aircraft Co., Inc., Long Beach, Calif.
METHODS FOR PREDICTING THE AERODYNAMIC AND STABILITY AND CONTROL CHARACTERISTICS OF STOL AIRCRAFT, VOLUME 1: BASIC THEORETICAL METHODS Final Report, 1 Jul. 1971 - 30 Dec. 1973

Mark I. Goldhammer, Michael L. Lopez, and Cheng-Chung Shen Dec. 1973 301 p refs
(Contract F33615-71-C-1861; AF Proj. 643A)
(AD-A001580; MDC-J5965-01; AFFDL-TR-73-146-Vol-1) Avail: NTIS CSCL 01/3

The primary goal of the study has been the development of a unified set of analytical methods which would provide the capability to calculate the stability and control characteristics of an arbitrary STOL aircraft configuration that might employ the internally ducted jet flap, externally blown jet flap, or a mechanical high lift system with vectored thrust. This volume presents the complete theoretical development of the relevant analytical methods. In addition, it presents comparisons of these methods with other analytical solutions and with experimental data. GRA

N75-17376# Douglas Aircraft Co., Inc., Long Beach, Calif.
METHODS FOR PREDICTING THE AERODYNAMIC AND STABILITY AND CONTROL CHARACTERISTICS OF STOL AIRCRAFT. VOLUME 2: STOL AERODYNAMIC METHODS COMPUTER PROGRAM Final Technical Report, 1 Jul. 1971 - 31 Nov. 1973

Mark I. Goldhammer and Norman F. Wasson Dec. 1973 229 p refs
(Contract F33615-71-C-1861; AF Proj. 643A)
(AD-A001581; MDC-J5965-02; AFFDL-TR-73-146-Vol-2)
Avail: NTIS CSCL 01/3

The report describes the STOL Aerodynamic Methods Computer Program, which is intended to aid the engineer in the design and analysis of STOL aircraft employing internally ducted jet flaps, externally blown jet flaps, and mechanical flap systems with vectored thrust. The program provides capabilities to predict either the overall aerodynamic characteristics of a configuration or the aerodynamics of the following: Jet-wing (in or out of ground effect); wing and vectored jets; fuselage in the flow field of the jet-wing and/or vectored jets; empennage in the flow field of the jet-wing and/or vectored jets. The program includes the capabilities for investigating the effects of arbitrary wing planforms with arbitrary high lift systems, including partial span flaps, slats, and jets; arbitrary camber, twist, and jet deflection; fuselages with arbitrary cross-sections and upsweep; arbitrary empennage arrangements, including conventional tails, mid-tails, and T-tails; and a capability to calculate the off-body flow field induced by the jet-wing and/or vectored at arbitrary points. GRA

N75-17377# Douglas Aircraft Co., Inc., Long Beach, Calif.
METHODS FOR PREDICTING THE AERODYNAMIC AND STABILITY AND CONTROL CHARACTERISTICS OF STOL AIRCRAFT. VOLUME 3: ENGINEERING METHODS Final Report, 1 Jul. 1971 - 30 Nov. 1973

Mark I. Goldhammer and Michael L. Lopez Dec. 1973 258 p refs
(Contract F33615-71-C-186116; AF Proj. 643A)
(AD-A001582; MDC-J5965-03; AFFDL-TR-73-146-Vol-3)
Avail: NTIS CSCL 01/3

This volume describes engineering methods for the prediction of the aerodynamic and stability and control characteristics of STOL aircraft employing internally ducted jet flaps, externally blown jet flaps, and mechanical flap systems with vectored thrust. These methods are intended to be used in conjunction with the theoretical methods and the associated computer program (STOL Aerodynamic Methods Computer Program) discussed in Volumes I and II, respectively. These engineering methods are intended to provide a rational approach for the aerodynamic analysis of complete STOL aircraft configurations and to provide semi-empirical methods to account for those effects not treated by the theoretical methods. These methods have been applied to configurations representative of each of the powered high-lift concepts, and the results of these analyses have been presented along with available experimental data to indicate the validity and range of applicability of the methods. GRA

N75-17378# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

VTOL AIRPLANE CONTROL IN TRANSITION REGIMES

A. P. Pashchenko 7 Oct. 1974 22 p Transl. into ENGLISH from Stroit. Mekh., Gazoerodinamika Proiz-vo Letateln. Appar- atov, Voronezh (USSR), no. 1, 1970 p 164-177
(AD-A000128; FTD-HC-23-1276-74) Avail: NTIS CSCL 01/3

The paper examines, from the problem formulation aspect, a fundamental scheme for semiautomatic control of the airplane in the transition regimes, which provides both reliable control of the airplane by the pilot and automatic stabilization of the airplane relative to the center of gravity. GRA

N75-17379# United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.

THREE-AXIS FLUIDIC/ELECTRONIC AUTOMATIC FLIGHT CONTROL SYSTEM FLIGHT TEST REPORT Final Report, 1 Jun. 1973 - 25 Jan. 1974

L. S. Cotton Aug. 1974 126 p refs
(Contract DAAG39-73-C-0237)
(AD-A000894; SER-50878; USAAMRD-TR-74-62) Avail: NTIS CSCL 13/7

This report covers the flight test of a three-axis Hydrofluidic Stability Augmentation System (HYSAS) coupled with a completely independent parallel attitude and heading hold for a CH-54B helicopter. The design goal was to evaluate the performance of the CH-54B Automatic Flight Control System (AFCS) with the electronic SAS replaced with a fluidic SAS and to establish the technical base for a fluidic inner loop and electronic outer loop control system. (Modified author abstract)

GRA

N75-17381# Virginia Univ., Charlottesville.

AN INVESTIGATION OF ROOFTOP STOLPORT AERODYNAMICS

Jeffrey N. Blanton and Hermon M. Parker [1972] 82 p refs
(Grant NGR-47-005-146)
(NASA-CR-132570) Avail: NTIS HC \$4.75 CSCL 01E

An investigation into aerodynamic problems associated with large building rooftop STOLports was performed. Initially, a qualitative flow visualization study indicated two essential problems: (1) the establishment of smooth, steady, attached flow over the rooftop, and (2) the generation of acceptable crosswind profile once (1) has been achieved. This study indicated that (1) could be achieved by attaching circular-arc rounded edge extensions to the upper edges of the building and that crosswind profiles could be modified by the addition of porous vertical fences to the lateral edges of the rooftop. Important fence parameters associated with crosswind alteration were found to be solidity, fence element number and spacing. Large scale building induced velocity fluctuations were discovered for most configurations tested and a possible explanation for their occurrence was postulated. Finally, a simple equation relating fence solidity to the resulting velocity profile was developed and tested for non-uniform single element fences with 30 percent maximum solidity. Author

N75-17383# Royal Aircraft Establishment, Farnborough (England). Structures Dept.

CIVIL AIRCRAFT AIRWORTHINESS DATA RECORDING PROGRAMME. UNEVEN RUNWAYS ENCOUNTERED BY SUBSONIC JET TRANSPORT AIRCRAFT DURING SCHEDULED AIRLINE OPERATIONS

G. B. Hutton London Aeron. Res. Council 1974 28 p refs
Supersedes RAE-TR-72095; ARC-34499
(ARC-CP-1287; RAE-TR-72095; ARC-34499; CAADRP-TR-25)
Avail: NTIS HC \$3.75; HMSO 50p; PHI \$2.15

During the Civil Aircraft Airworthiness Data Recording Program instances were found where runway unevenness at two international airports produced CG normal acceleration oscillations of unusually large amplitudes for brief periods during the takeoff or landing run. Flight records of events are reproduced and discussed, one runway/aircraft combination being dealt with in particular detail owing to the phenomenon occurring frequently and being a source of comment from pilots. There has been no known evidence of aircraft damage resulting from the events but some contribution to fatigue damage could occur, particularly on aircraft types with heavy wing-mounted appendages. It is suggested that selective resurfacing of the runways could considerably alleviate the loading action. Author (ESRO)

N75-17384# European Space Research Organization, Paris (France).

AIRCRAFT FLUTTER SIMULATION BY MEANS OF THE ELECTRONIC ANALOGUE COMPUTER WITH SPECIAL REGARD TO STRUCTURAL NONLINEARITIES

E. Breitbach Dec. 1974 128 p refs Transl. into ENGLISH of Flattersimulation des Flugzeuges mit Hilfe des Elektron. Analogrechners unter besonderer Berücksichtigung struktureller Nichtlinearitäten DLR-FB-73-30, DFVLR, Jan. 1973 (ESRO-TT-121; DLR-FB-73-30) Avail: NTIS HC \$5.75; DFVLR, Porz, West Ger. 39DM

The fundamental theoretical relations for aircraft flutter simulation by means of an electronic analogue computer and a general description of an appropriate computer realization are presented. Proceeding from Lagrange's equations the governing aeroelastic stability equations are given in terms of natural mode functions. For a real time flutter simulation the unsteady aerodynamic forces are determined by application of the two-dimensional incompressible strip theory including Wagner's function for arbitrary non-uniform motions. The practical application of the developed method is demonstrated for a wing-aileron system, and some typical results are presented and discussed. As a special advantage of the analogue simulation, the influence of a nonlinear aileron hinge stiffness on the flutter stability is investigated for numerous variations of spring characteristics. Author (ESRO)

N75-17385# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

METHOD OF ELECTROMECHANICAL SIMULATION OF THE ELASTIC OSCILLATIONS OF AN AIRCRAFT IN FLIGHT V. I. Smyslov and S. P. Strelkov 15 Oct. 1974 15 p refs Transl. into ENGLISH from Izv. Vysshikh Uchebn. Zavedenii, Aviats. Tekhn. (Kazan), v. 10, no. 40, 1967 p 88-93 (AD-A000645; FTD-HT-23-1962-74) Avail: NTIS CSCL 20/4

Owing to the variety of designs and appearance of aircraft it is quite difficult to correctly determine the initial forms or critical rate of flutter, and new methods of research on elastic oscillations of an aircraft in flight are investigated. One of these, the method of electromechanical simulation of the elastic oscillations of an aircraft in flight, is described. GRA

N75-17391# School of Aerospace Medicine, Brooks AFB, Tex. **A LASER-GENERATED VISUAL DISPLAY AND TRACKING TASK FOR A LINK GAT-1 FLIGHT TRAINER** Final Report, Mar. 1973 - Jun. 1974

Peter H. Henry and Edward J. Engelken Sep. 1974 31 p refs (AD-A001079; SAM-TR-74-36) Avail: NTIS CSCL 05/9

A prototype test system has been developed for use with a Singer Co. GAT-1 flight trainer that permits assessment of a pilot's ability to track a target which moves about three separate axes: vertically (altitude), laterally, and in depth (range). A low-cost laser-generated visual display and rear projection screen was used to create the visual tracking task which is crudely akin to aerial refueling or formation flying. Performance was assessed on-line in terms of: (1) integrated absolute tracking error and (2) time on target, by using a bench top analog computer (EAI model TR-10) and simple hardware. GRA

N75-17425# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

MEASUREMENT OF ADVANCED COMPOSITION MATERIALS SHIELDING EFFECTIVENESS Final Report, Mar. 1972 - Jan. 1973

D. G. Kim, G. A. DuBro, and R. C. Beavin Jun. 1974 45 p refs (AF Proj. 1987) (AD-A000414; AFFDL-TR-30-74) Avail: NTIS CSCL 11/4

The work was conducted to define the shielding characteristics of advanced composite materials. The report discusses the experimental evaluation of the shielding effectiveness of advanced boron and graphite composites with and without conductive layers at low-to-moderate frequencies. GRA

N75-17531# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.

JET FUEL THERMAL STABILITY IMPROVEMENTS THROUGH FUEL PROCESSING Final Report, Jan. 1970 - 31 Dec. 1973

Herbert R. Lander, Jr. and Charles R. Martel Aug. 1974 37 p refs (AF Proj. 3048) (AD-A001623; AFAPL-TR-74-35) Avail: NTIS CSCL 21/4

The effectiveness of various refining processes in upgrading the thermal stability of aircraft turbine engine fuels has been examined. A Jet A-1 fuel was subjected to clay-treatment, desulfurization, and hydrogenation. The thermal stability of the treated and untreated fuels was determined using the Jet Fuel Thermal Oxidation Tester (JFTOT) thermal stability method. Desulfurization increased the JFTOT breakpoint by 120 to 140F, and desulfurization followed by hydrogenation increased the JFTOT breakpoint of the fuel by more than 150F. A low-aromatic JP-4 type of fuel, blended from a hydrogenated stock and a solvent-treated stock to remove aromatics, was also tested and compared to a conventional JP-4 fuel. Desulfurization, hydrogenation, clay treatment, and aromatic solvent extraction have been shown to be effective methods for upgrading the thermal stability of jet fuels. GRA

N75-17573# Raytheon Co., Wayland, Mass. Equipment Div. **ASR-5 RADAR DUAL FEEDHORN ANTENNA MODIFICATION. VOLUME 1: DESCRIPTION OF HARDWARE AND SUMMARY OF FEASIBILITY EFFORT** Final Report, Jun. 1969 - Aug. 1972

P. E. Rawlinson Apr. 1974 144 p refs 2 Vol. (Contract DOT-FA69WA-2129)

(AD-781348; FAA-RD-74-88-1-Vol-1) Avail: NTIS HC \$4.50

Separate antenna two-way coverage patterns were examined for the close-in and long range capabilities of the terminal radar system. The feedhorn geometry of the ASR-5 antenna was modified by adding a separate receive only feedhorn and polarizer. The close-in coverage was obtained by transmission on the normal (low) beam and reception on the second (high or tilted-up) beam. The long range coverage was obtained by both transmission and reception on the normal beam. The results and conclusions drawn from the program are that the receive-only antenna pattern has an acceptable sidelobe level, azimuth beamwidth, elevation beam shape and integrated cancellation ratio; that the normal ASR-5 antenna pattern suffers minimal degradation in both linear and circular polarization; and that a field modification of this system is feasible. Author

N75-17611# Florida Univ., Gainesville. Dept. of Engineering Sciences.

A MODEL FOR THE VORTEX PAIR ASSOCIATED WITH A JET IN A CROSS FLOW M.S. Thesis

William L. Sellers, III 1975 87 p refs (Grant NGR-10-005-127)

(NASA-CR-136756) Avail: NTIS HC \$4.75 CSCL 20D

A model is presented for the contrarotating vortex pair that is formed by a round, turbulent, subsonic jet directed normally into a uniform, subsonic cross flow. The model consists of a set of algebraic equations that describe the properties of the vortex pair as a function of their location in the jet plume. The parameters of the model are physical characteristics of the vortices such as the vortex strength, spacing, and core size. These parameters are determined by velocity measurements at selective points in the jet plume. Author

N75-17614# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.

SKIN FRICTION REDUCTION IN SUPERSONIC FLOW BY INJECTION THROUGH SLOTS, POROUS SECTIONS AND COMBINATIONS OF THE TWO Final Report

Joseph A. Schetz and Johannes VanOvereem Washington NASA Mar. 1975 62 p refs (Grant NGR-47-004-160) (NASA-CR-2491) Avail: NTIS HC \$4.25 CSCL 20D

An experimental study of skin friction reduction in a Mach 3.0 air stream with gaseous injection through a tangential slot, a porous wall section, and combinations of the two was conducted. The primary data obtained were wall shear values measured directly with a floating element balance and also inferred from Preston Tube measurements. Detailed profiles at several axial stations, wall pressure distributions and schlieren photographs are presented. The data indicate that a slot provides the greatest skin friction reduction in comparison with a reference flat plate experiment. The porous wall section arrangement suffers from an apparent roughness-induced rise in skin friction at low injection rates compared to the flat plate. The combination schemes demonstrated a potential for gain. Author

N75-17624# Hydronautics, Inc., Laurel, Md.
EFFECT OF DRAG-REDUCING POLYMER INJECTION ON THE LIFT AND DRAG OF A TWO-DIMENSIONAL HYDRO-FOIL

D. A. Fruman, T. R. Sundaram, and S. J. Daugard Sep. 1974 38 p refs
 (Contract N00014-71-C-0063; NR Proj. 062-325)
 (AD-A000262; TR-7101-R) Avail: NTIS CSCL 13/10

The present paper describes an experimental investigation on the effects of injecting drag-reducing polymer solutions into the turbulent boundary layer of two NACA 63, two-dimensional, symmetrical, hydrofoils. The experiments were performed in a high-speed circulating channel with free stream velocities of up to 13 m/sec. The two foils used were 10 and 20 cm in chord, though both had a maximum thickness of 2 cm. The incidence of the foils varied between plus or minus 5 degrees with the ratios of the injection to free stream velocity of up to 0.2, and a concentration of poly(ethylene oxide), POLYOX WSR 301, of 200 ppm. The injection slits on both foils are situated one-tenth of a chord downstream of the leading edge. The gap of the injection slit was 0.0127 cm for the small foil and twice this value for the larger foil. (Modified author abstract) GRA

N75-17626# New York Univ., N.Y. Div. of Applied Science.
STUDIES OF SEPARATED FLOWS Final Report
 Roberto Vaglio-Laurin Sep. 1974 18 p refs
 (Grant AF-AFOSR-2316-72; AF Proj. 9783)

(AD-A000348; AFOSR-74-1740TR) Avail: NTIS CSCL 20/4
 The report describes turbulent boundary layers in strong interaction with inviscid flows around transonic airfoils. These flows can be analyzed by the procedures developed for laminar problems, provided specific families of solutions are used to describe the boundary layer profiles in different regions, such as through a maximum as the amount of water increased. Surfactants first decrease the pseudoplastic behavior, and then at higher concentrations, surfactants cause the suspensions to become Newtonian in behavior. A theory was developed in an attempt to explain the experimental results. The theory predicts pseudoplastic flow behavior for agglomerated suspensions, but the quantitative correlation between theory and experiment is not satisfactory. GRA

N75-17653# National Weather Service, Sterling, Va. Test and Evaluation Lab.

EVALUATION OF A SPERRY LIDAR CEILOMETER Final Report, Apr. 1973 - Mar. 1974

David H. George Feb. 1974 43 p refs
 (Contract DOT-FAA-ER-450-006)

(AD-777820; FAA-RD-74-23) Avail: NTIS HC \$3.25

An evaluation of a Sperry Lidar Ceilometer was made relative to the Rotating Beam Ceilometer (RBC). The lidar ceilometer is described. Digital and analog cloud height data from the lidar ceilometer and analog cloud height data from the RBC were recorded and analyzed. Comparison of lidar and RBC cloud height measurements showed that RBC tends toward greater cloud height and the lidar tends toward lower cloud height. The lidar is shown to be an improvement over the RBC in terms of installation, maintenance, and operation. Author

N75-17707# National Aerospace Lab., Tokyo (Japan).

ON THE NATURAL VIBRATION OF PLATE-BEAM COMBINATION STRUCTURES. 4

Taketoshi Hanawa and Keiji Komatsu 1974 39 p refs In JAPANESE; ENGLISH summary
 (NAL-TR-363) Avail: NTIS HC \$3.75

The application of an analytical method, by use of the Rayleigh-Ritz procedure, to the analysis of natural vibration characteristics in plate-beam structures is considered. As actual examples, structures consisting of built-up wings with an aspect ratio of about 9 and a cylindrical fuselage were dealt with. General analytical equations were formulated for these. Numerical examples were considered for models consisting of combination beam, cantilevered built-up wing, and boomerang type wings applying the formula to these special cases and a model consisting of a cylindrical fuselage and built-up wings. At the same time, vibration tests of these models were carried out. Comparisons of both results showed that there were fairly good correlations between them, though there are some troubles, which were examined numerically, in the calculation of the eigenvalues. It is concluded that this analytical method cannot be overlooked, as it is one of the most suitable ways of predicting vibration characteristics of these structures in the earlier design phase, although the powerful matrix method is widely applied to these complicated or real airplane structures. Author

N75-17709# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

STRUCTURAL RESPONSE OF A FIBER COMPOSITE COMPRESSOR FAN BLADE AIRFOIL

C. C. Chamis and M. D. Minich (Cleveland State Univ.) 1975 34 p refs Presented at Gas Turbine Conf. and Prod. Show, Houston, Tex., 2-6 Mar. 1975

(NASA-TM-X-71623; E-8147) Avail: NTIS HC \$3.75 CSCL 20K

A theoretical investigation was performed to determine the structural response of a fiber composite airfoil typical of those encountered in high-tip speed compressor fan blades when subjected to load conditions anticipated in such applications. The analysis method consisted of composite mechanics embedded in pre- and post-processors coupled with NASTRAN. The load conditions examined include thermal due to aerodynamic heating, pressure due to aerodynamic forces, and centrifugal. Root reactions due to various load conditions, average composite and ply stresses, ply delaminations, and the fundamental modes and the corresponding reactions were investigated. The results show that the thermal and pressure stresses are negligible compared to those caused by the centrifugal forces. The core-shell concept for composite blades is an inefficient design and is sensitive to interply delaminations. The results are presented in graphical and tabular forms to illustrate the types and amount of data required for the analysis, and to provide quantitative data associated with the various responses which can be helpful in designing composite blades. Author

N75-17711# Clemson Univ., S.C. Mechanical Engineering Dept.

OPTIMIZATION OF STRUCTURES TO SATISFY A FLUTTER VELOCITY CONSTRAINT BY USE OF QUADRATIC EQUATION FITTING M.S. Thesis

Saifee K. Motiwalla 6 Feb. 1973 42 p refs
 (Grant NGR-41-001-027)

(NASA-CR-132628) Avail: NTIS HC \$3.75 CSCL 20K

Using the first and the second derivative of flutter velocity with respect to the parameters, the velocity hypersurface is made quadratic. This greatly simplifies the numerical procedure developed for determining the values of the design parameters such that a specified flutter velocity constraint is satisfied and the total structural mass is near a relative minimum. A search procedure is presented utilizing two gradient search methods and a gradient projection method. The procedure is applied to the design of a box beam, using finite-element representation. The results indicate that the procedure developed yields substantial design improvement satisfying the specified constraint and does converge to near a local optimum. Author

N75-17835# Federal Aviation Administration, Washington, D.C. Aircraft Safety and Noise Abatement Div.

ENGINEERING AND DEVELOPMENT PROGRAM PLAN: AIRCRAFT PROPULSION SYSTEMS AIR POLLUTION

Feb. 1974 36 p ref

(AD-777484; FAA-ED-20-1) Avail: NTIS HC \$3.25

A program plan to develop the means to measure, reduce, and control air pollution from aircraft powerplants and support systems is presented. The following areas of endeavor are described: (1) measurement technique development; (2) engine emission reduction; (3) general aviation emissions investigations; (4) airport pollution investigations; (5) advanced propulsion and support systems investigations; and (6) operational impact assessments. J.M.S.

N75-18030*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

ON THE EXCESS ATTENUATION OF SOUND IN THE ATMOSPHERE

Richard DeLoach Washington Mar. 1975 74 p refs

(NASA-TN-D-7823; L-9724) Avail: NTIS HC \$4.25 CSCL 20A

The attenuation suffered by an acoustic plane wave propagating from an elevated source to the ground, in excess of absorption losses, was studied. Reported discrepancies between attenuation measurements made in the field and theories which only account for absorption losses are discussed. It was concluded that the scattering of sound by turbulence results in a non-negligible contribution to the total attenuation. Author

N75-18167*+ New York Univ., N.Y.

SUPERCritical WING SECTIONS 2. VOLUME 108

Frances Bauer, Paul Garabedian, David Korn, Antony Jameson, M. Beckmann, ed., and H. P. Kuenzi, ed. 1975 301 p (Grants NGR-33-016-201; NGR-33-016-167; Contract AT(11-1)-3077)

(NASA-CR-142229) Copyright. Avail: NTIS HC \$9.25 CSCL 01A

A mathematical theory for the design and analysis of supercritical wing sections was previously presented. Examples and computer programs showing how this method works were included. The work on transonics is presented in a more definitive form. For design, a better model of the trailing edge is introduced which should eliminate a loss of fifteen or twenty percent in lift experienced with previous heavily aft loaded models, which is attributed to boundary layer separation. How drag creep can be reduced at off-design conditions is indicated. A rotated finite difference scheme is presented that enables the application of Murman's method of analysis in more or less arbitrary curvilinear coordinate systems. This allows the use of supersonic as well as subsonic free stream Mach numbers and to capture shock waves as far back on an airfoil as desired. Moreover, it leads to an effective three dimensional program for the computation of transonic flow past an oblique wing. In the case of two dimensional flow, the method is extended to take into account the displacement thickness computed by a semi-empirical turbulent boundary layer correction. Author

N75-18169*# National Aeronautics and Space Administration. Wallops Station, Wallops Island, Va.

PILOT PREFERENCE AND PROCEDURES AT UNCONTROLLED AIRPORTS

Lloyd C. Parker Washington Mar. 1975 29 p refs

(NASA-TN-D-7928) Avail: NTIS HC \$3.75 CSCL 05E

The report presents the results of a pilot questionnaire utilized at the 1974 Reading, Pennsylvania Air Show to obtain data on pilot procedures and preference in the terminal airspace of uncontrolled airports. Author

N75-18172 Polish Academy of Sciences, Warsaw.

STATIONARY REACTION OF A DUAL-SPHERE CONFIGURATION MOVING IN A FREE-MOLECULAR MEDIUM [STACJONARNE ODDZIALYWANIE UKŁADU DWU KUL PORUSZAJĄCEGO SIE W OSRODKU SWOBODNIE-MOLEKULARNYM]

Stanislaw Kosowski 27 Jun. 1973 282 p In POLISH (Rept-36/1973) Avail: Issuing Activity

The stationary exchange is discussed of momentum and energy for a two body system moving in a free molecular medium in rarefied gases with a uniform rectilinear motion. The classical problem of heat resistance and heat exchange for this system was investigated. It was found that transfer of momentum and energy occurs equally between the body and the medium, and between bodies through the medium's particles.

Transl. by M.J.S.

N75-18173+ Engineering Sciences Data Unit, London (England). CONVERSION FACTOR FOR PROFILE DRAG INCREMENT FOR PART-SPAN FLAPS

Jul. 1974 3 p ref

(ESDU-Flaps-02.01.07-Amend-A/B) Copyright. Avail: NTIS HC \$7.50

The conversion factor for deriving the drag increment of part-span flaps of all types is plotted against the ratio of flap span to wing span. It is assumed that the flap chord to wing chord is constant along the span. Where only a central cut-out exists, the overall conversion factor is the difference between the conversion factor for unbroken flap span and the conversion factor for a flap of span equal to that of the gap. A diagram of the aircraft wing which shows the significant dimensions is provided. Author

N75-18174# Brussels Univ. (Belgium). Inst. d'Aeronautique. EXPERIMENTAL STUDY OF A TWO PRESSURE STAGE AIR CUSHION [ETUDE EXPERIMENTALE DU COUSSIN D'AIR A DEUX ETAGES DE PRESSION]

A. Jaumotte, A. Kiedrzyński, and C. Haesevoets 1974 64 p refs In FRENCH

(NT-36) Avail: NTIS HC \$4.25

The characteristics of a two pressure stage air cushion are studied. Data cover pressure distribution between the two stages, flow coefficients and recovery of peripheral jet flow velocity on the sphere of the two stages. Empirical formulations and bidimensional models were used for the study.

Transl. by E.H.W.

N75-18175# Aeronautical Research Labs., Melbourne (Australia). TRANSONIC WIND TUNNEL TESTS ON TWO BLUNT TRAILING EDGE AEROFOILS

N. Pollock Sep. 1974 29 p refs

(ARL/A-Note-351) Avail: NTIS HC \$3.75

Two blunt trailing edge airfoil sections were tested in a transonic wind tunnel and their aerodynamic characteristics compared with those of a conventional NACA 64-106 section previously tested under identical conditions. The two blunt sections used a segmented trailing edge geometry to minimize their base drag. This segmented trailing edge geometry consisted of isolated rectangular blocks protruding downstream from the base with splitter plates spanning the spaces between the blocks. Both blunt sections had superior transonic stability, greater resistance to separation, and greater bending strength than the NACA section. One of the blunt sections also had less drag than the NACA section over the whole test range of lift coefficients for a significant portion of the transonic Mach number range. Author

N75-18176*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

WIND TUNNEL INVESTIGATION OF THE WAKE NEAR THE TRAILING EDGE OF A DISTRIBUTED UPPER-SURFACE-BLOWN FLAP

David R. Forsyth (George Washington Univ.), Long P. Yip, and Alvin M. Bloom (George Washington Univ.) Jan. 1975 331 p refs

(NASA-TM-X-72637) Avail: NTIS HC \$9.50 CSCL 01A

An investigation of the flow field near the trailing edge of a distributed upper-surface-blown propulsive-lift transport was conducted in the Langley V/STOL tunnel. This model used blowing

to installation of the ejector nozzle. The wind tunnel program showed a reduction of 2 PNdB in the sideline plane due to a forward speed of 43.8 m/s (85 kn). The best combination of noise reduction concepts reduced the sideline noise of the reference aircraft at constant field length by 4 PNdB. Author

N75-18177*# Lockheed-Gear Co., Marietta.
STATIC AND WIND TUNNEL MODEL TESTS FOR THE DEVELOPMENT OF EXTERNALLY BLOWN FLAP NOISE REDUCTION TECHNIQUES

A. P. Pennock, G. Swift, and J. A. Marbert 17 Mar. 1975 323 p refs
 (Contract NAS3-16831)
 (NASA-CR-134675; LG74ERO170) Avail: NTIS HC\$9.25 CSCL 01B

Externally blown flap models were tested for noise and performance at one-fifth scale in a static facility and at one-tenth scale in a large acoustically-treated wind tunnel. The static tests covered two flap designs, conical and ejector nozzles, third-flap noise-reduction treatments, internal blowing, and flap/nozzle geometry variations. The wind tunnel variables were triple-slotted or single-slotted flaps, sweep angle, and solid or perforated third flap. The static test program showed the following noise reductions at takeoff: 1.5 PNdB due to treating the third flap; 0.5 PNdB due to blowing from the third flap; 6 PNdB at flyover and 4.5 PNdB in the critical sideline plane (30 deg elevation) due slots across the entire wing span to produce a thin jet efflux near the leading edge and at the knee of the flap. Velocity surveys of the flow field were taken near the trailing edge of the model, and are presented as plots of the individual velocity vectors. The test conditions include an angle-of-attack range from 4 deg to 16 deg and a thrust coefficient range from 0 to 1.3 at a free-stream dynamic pressure of 814 Newton per square meter (17 pounds per square foot). Author

N75-18178*# Rochester Applied Science Associates, Inc., N.Y.
DEVELOPMENT OF AN ANALYSIS FOR THE DETERMINATION OF COUPLED HELICOPTER ROTOR/CONTROL SYSTEM DYNAMIC RESPONSE. PART 1: ANALYSIS AND APPLICATIONS Final Report

Lawrence R. Sutton and Stephen A. Rinehart Washington NASA Jan. 1975 115 p refs
 (Contract NAS1-10856)
 (NASA-CR-2452) Avail: NTIS HC\$5.25 CSCL 01C

A theoretical analysis is developed for a coupled helicopter rotor system to allow determination of the loads and dynamic response behavior of helicopter rotor systems in both steady-state forward flight and maneuvers. The effects of an anisotropically supported swashplate or gyroscope control system and a deformed free wake on the rotor system dynamic response behavior are included in the analysis. Author

N75-18179*# National Aeronautics and Space Administration.
Langley Research Center, Langley Station, Va.
AN ANALYSIS METHOD FOR TWO-DIMENSIONAL TRANSONIC VISCOUS FLOW

Paul C. Bavitz (Grumman Aerospace Corp.) Washington Jan. 1975 119 p refs
 (NASA-TN-D-7718; L-9708) Avail: NTIS HC\$5.25 CSCL 01A

A method for the approximate calculation of transonic flow over airfoils, including shock waves and viscous effects, is described. Numerical solutions are obtained by use of a computer program which is discussed in the appendix. The importance of including the boundary layer in the analysis is clearly demonstrated, as well as the need to improve on existing procedures near the trailing edge. Comparisons between calculations and experimental data are presented for both conventional and supercritical airfoils, emphasis being on the surface pressure distribution, and good agreement is indicated. Author

N75-18180*# National Aeronautics and Space Administration.
Langley Research Center, Langley Station, Va.
EFFECTS OF NOZZLE INTERFAIRING MODIFICATIONS ON LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A TWIN JET, VARIABLE WING SWEEP FIGHTER MODEL

David E. Reubush and Charles E. Mercer Washington Feb. 1975 128 p refs
 (NASA-TN-D-7817; L-9802) Avail: NTIS HC\$5.75 CSCL 01A

A wind-tunnel investigation has been made to determine the effects of nozzle interfairing modifications on the longitudinal aerodynamic characteristics of a twin-jet, variable-wing-sweep fighter model. The model was tested in the Langley 16-foot transonic tunnel at Mach numbers of 0.6 to 1.3 and angles of attack from about minus 2 deg to 6 deg and in the Langley 4-foot supersonic pressure tunnel at a Mach number of 2.2 and an angle of attack of 0 deg. Compressed air was used to simulate nozzle exhaust flow at jet total-pressure ratios from 1 (jet off) to about 21. The results of this investigation show that the aircraft drag can be significantly reduced by replacing the basic interfairing with a modified interfairing. Author

N75-18181*# National Aeronautics and Space Administration.
Ames Research Center, Moffett Field, Calif.

APPLICATION OF NUMERICAL OPTIMIZATION TO THE DESIGN OF LOW SPEED AIRFOILS

Raymond M. Hicks and Garret N. Vanderplaats Washington Mar. 1975 29 p refs
 (NASA-TM-X-3213; A-5863) Avail: NTIS HC\$3.75 CSCL 01B

A practical procedure for the optimum design of low-speed airfoils is demonstrated. The procedure uses an optimization program based on the method of feasible directions coupled with an aerodynamic analysis program that uses a relaxation solution of the inviscid, full potential equation. Results are presented for airfoils designed to have small adverse pressure gradients, high maximum lift, and low pitching moment. Author

N75-18182*# National Aeronautics and Space Administration.
Langley Research Center, Langley Station, Va.

PREDICTION OF AIRFRAME NOISE

Jay C. Hardin (Bolt, Beranek, and Newman, Inc., Boston), David J. Fratello, Richard E. Hayden, Yoran Kadman (Bolt, Beranek, and Newman, Inc., Boston), and Steven Africk (Bolt, Beranek, and Newman, Inc., Boston) Washington Feb. 1975 115 p refs
 (NASA-TN-D-7821; L-9912) Avail: NTIS HC\$5.25 CSCL 01A

Methods of predicting airframe noise generated by aircraft in flight under nonpowered conditions are discussed. Approaches to predictions relying on flyover data and component theoretical analyses are developed. A nondimensional airframe noise spectrum of various aircraft is presented. The spectrum was obtained by smoothing all the measured spectra to remove any peculiarities due to airframe protrusions, normalizing each spectra by its overall sound pressure level and a characteristics frequency, and averaging the spectra together. A chart of airframe noise sources is included. Author

N75-18183*# National Aeronautics and Space Administration.
Ames Research Center, Moffett Field, Calif.

FLAPPING RESPONSE CHARACTERISTICS OF HINGELESS ROTOR BLADES BY A GENERALIZED HARMONIC BALANCE METHOD

David A. Peters and Robert A. Ormiston Washington Feb. 1975 140 p Prepared in cooperation with Army Air Mobility R and D Lab., Moffett Field, Calif.
 (NASA-TN-D-7856; A-5494) Avail: NTIS HC\$5.75 CSCL 01A

Linearized equations of motion for the flapping response of flexible rotor blades in forward flight are derived in terms of generalized coordinates. The equations are solved using a matrix form of the method of linear harmonic balance, yielding response derivatives for each harmonic of the blade deformations and of the hub forces and moments. Numerical results and approximate closed-form expressions for rotor derivatives are used to illustrate the relationships between rotor parameters, modeling assumptions, and rotor response characteristics. Finally, basic hingeless rotor

response derivatives are presented in tabular and graphical form for a wide range of configuration parameters and operating conditions. Author

N75-18184* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN EXPERIMENTAL SIMULATION STUDY OF FOUR CROSSWIND LANDING GEAR CONCEPTS

Sandy M. Stubbs, Thomas A. Byrdson, and Robert K. Sleeper Washington Mar. 1975 57 p refs (NASA-TN-D-7864; L-9899) Avail: NTIS HC \$4.25 CSCL 01C

An experimental investigation was conducted in order to evaluate several crosswind landing-gear concepts which have a potential application to tricycle-gear-configured, short take-off and landing (STOL) aircraft landing at crab or heading angles up to 30 deg. In this investigation, the landing gears were installed on a dynamic model which had a scaled mass distribution and gear spacing but no aerodynamic similarities when compared with a typical STOL aircraft. The model was operated as a free body with radio-control steering and was launched onto a runway sloped laterally in order to provide a simulated crosswind side force. During the landing rollout, the gear forces and the model trajectory were measured and the various concepts were compared with each other. Within the test limitations, the landing gear system, in which the gears were aligned by the pilot and locked in the direction of motion prior to touchdown, gave the smoothest runout behavior with the vehicle maintaining its crab angle throughout the landing runout. Author

N75-18185* Boeing Commercial Airplane Co., Seattle, Wash. **AERODYNAMIC DESIGN AND ANALYSIS SYSTEM FOR SUPERSONIC AIRCRAFT. PART 1: GENERAL DESCRIPTION AND THEORETICAL DEVELOPMENT** Final Contractor Report, Jan. 1973 - Nov. 1974

W. D. Middleton and J. L. Lundry Washington NASA Mar. 1975 76 p refs (Contract NAS1-12052) (NASA-CR-2520; D6-41768) Avail: NTIS HC \$4.75 CSCL 01C

An integrated system of computer programs has been developed for the design and analysis of supersonic configurations. The system uses linearized theory methods for the calculation of surface pressures and supersonic area rule concepts in combination with linearized theory for calculation of aerodynamic force coefficients. Interactive graphics are optional at the user's request. This part presents a general description of the system and describes the theoretical methods used. Author

N75-18186* Boeing Commercial Airplane Co., Seattle, Wash. **AERODYNAMIC DESIGN AND ANALYSIS SYSTEM FOR SUPERSONIC AIRCRAFT. PART 3: COMPUTER PROGRAM DESCRIPTION** Final Contractor Report, Jan. 1973 - Nov. 1974

W. D. Middleton, J. L. Lundry, and R. G. Coleman Washington NASA Mar. 1975 94 p refs (Contract NAS1-12052) (NASA-CR-2522; D6-41769) Avail: NTIS HC \$4.75 CSCL 01C

The computer program for the design and analysis of supersonic aircraft configurations is presented. The schematics of the program structure are provided. The individual overlays and subroutines are described. The system is useful in determining surface pressures and supersonic area rule concepts. Author

N75-18187* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AERODYNAMIC TESTING TECHNIQUE FOR TWIN FUSELAGE MODELS AT HYPERSONIC SPEEDS

George C. Ashby, Jr. Washington Mar. 1975 15 p refs (NASA-TM-X-3196; L-10004) Avail: NTIS HC \$3.25 CSCL 01A

A testing technique for obtaining the static aerodynamic characteristics of twin-fuselage configurations at hypersonic speeds by using a conventional single-balance installation has been evaluated. Data from a triple-fuselage model and a single-fuselage model were summed and then halved to obtain the characteristics for a twin-fuselage model of the same scale. The three related models were evaluated experimentally at Mach 20.3 in helium and Mach 6 in air for an angle-of-attack range from minus 6 deg to 50 deg. The Reynolds numbers, based on model length, were 1.88 million for the Mach 20.3 tests and 2.55 million for the Mach 6 tests. Author

N75-18188* ARO, Inc., Arnold Air Force Station, Tenn. **ANALYTICAL STUDY OF VENTILATED WIND TUNNEL BOUNDARY INTERFERENCE ON V/STOL MODELS INCLUDING WAKE CURVATURE AND DECAY EFFECTS** Final Report, Feb. - Oct. 1973

E. M. Kraft Nov. 1974 59 p refs Sponsored by NASA (NASA-CR-142240; AD-A000922; ARO-PWT-TR-74-30; AEDC-TR-74-51) Avail: NTIS HC \$4.25 CSCL 01/3

The wind tunnel boundary interference on a V/STOL model is calculated in a rectangular test section with solid vertical walls and ventilated (perforated or slotted) horizontal walls. The interference is found by applying the small perturbation theory of an incompressible fluid to the boundary value problem. The theory uses an image method in addition to Fourier transforms with an equivalent homogeneous boundary condition on the ventilated wall. The mathematical representation of the V/STOL model accounts for the curvature and decay of the wake. The assumption of a constant wake strength produces a paradox in that the maximum value of the interference factors increases as the initial jet velocity decreases. The most significant aspect of the analysis shows that nonlinear cross-flow effects at the tunnel boundary are important in the V/STOL case, and a quasi-linear approximation to these effects is introduced into the solution providing good agreement with experimental data. GRA

N75-18189* General Dynamics/Convair, San Diego, Calif. Aerospace Div.

AIRFOIL OPTIMIZATION UTILIZING A REMOTELY CONTROLLED FLEXIBLE MODEL. PHASE 1: LOW SPEED WIND TUNNEL TEST Technical Report, 15 Dec. 1973 - 31 Aug. 1974

E. S. Levinsky and R. H. Schappelle 31 Aug. 1974 81 p refs (Contract N00014-74-C-0127; NR Proj. 212-224)

(AD-A001094; CASD-NSC-74-007) Avail: NTIS CSCL 01/1

An interactive wind tunnel technique for optimizing airfoil shapes has been demonstrated. The tests were carried out at the General Dynamics Low Speed Tunnel and utilized a flexible airfoil whose shape could be varied with remotely controllable servo-hydraulic actuators located inside the airfoil. The test operation consisted of a sequence of incremental and simultaneous mode runs. Gradient data were generated during the incremental mode runs and were inputted into the computer. The computer supplied an optimal direction for changing the actuators and angle of attack to minimize (or maximize) the prescribed merit function, subject to equality and inequality constraints. The actuators and angle of attack were moved gradually in the optimal direction during a simultaneous mode run, and the airfoil shape which produced the minimum merit function was selected from which to begin a new incremental mode run. GRA

N75-18190* Iowa Univ., Iowa City. Div. of Energy Engineering.

AERODYNAMIC HEATING OF SUPERSONIC BLUNT BODIES Final Report, 7 Jan. - 31 Aug. 1974

David C. Chou and Theodore F. Smith Sep. 1974 57 p refs (Grant DAHC04-74-G-0097) (AD-A001135; E-DCC-74-001; ARO-12117-1-RTL) Avail: NTIS CSCL 16/3

The object of the research is to investigate the rate of

aerodynamic heat transfer on the surface of a blunt body of revolution flying at supersonic speed. A mathematical model, based on Illingworth-Stewartson transformation and a perturbation technique with a similarity analysis, which describes the aerodynamic heating processes associated with supersonic flight of a blunt-nose projectile has been developed. The governing transport equations are reduced to a set of coupled nonlinear ordinary differential equations in first, third, and fifth order of the transformed coordinates. The equations were solved by a standard numerical integration scheme. Results describing velocity and temperature, profiles inside the boundary layer, skin friction and local heat transfer rates are presented. GRA

N75-18191# Arnold Engineering Development Center, Arnold Air Force Station, Tenn.

STATIC PRESSURE ON SHARP AND BLUNT CONES IN CONICAL AND PARALLEL LOW-DENSITY FLOW Final Report, 1 Oct. 1971 - 31 Mar. 1972

Max Kinslow AEDC Nov. 1974 74 p refs

(AD-A001632; ARO-VM2266; AEDC-TR-74-30) Avail: NTIS CSCL 16/2

The static pressure distribution on sharp and blunt 10-deg half-angle cones was measured under rarefied conditions in both a uniform and a source flow field. Angle of attack of the cones was varied up to 10 deg. Pressure distributions are presented for cold-wall conditions at $18.0 = \text{or} < \text{Mach number}$ $= \text{or} < 20.3$ and $407 < \text{Reynolds number/in.} = \text{or} < 1272$. The source flow results are corrected according to the Newtonian pressure distribution, and the results agree with the uniform flow measurements for the longitudinal distribution at zero angle of attack. Comparisons are made with previous experimental and theoretical results. GRA

N75-18192# TRW Systems Group, Redondo Beach, Calif., Transportation and Environmental Operations.

THE AERODYNAMICS OF VEHICLES IN FINITE LENGTH TUBES Final Report, Sep. 1972 - Oct. 1973

Andrew G. Hammitt Apr. 1974 85 p refs

(Contract DOT-FR-30004)

(PB-236692/O; TRW-96034-L014-0; FRA-ORD/D-74-10) Avail: NTIS HC \$4.75 CSCL 13B

The aerodynamics of vehicles traveling through tubes are significantly affected by the constraints of the tube wall and the relative size (blockage ratio) of the vehicle. Steady flow conditions are reached only after long travel times. In this report, the flow created by vehicle travel in a tube is analyzed using numerical integration of the unsteady flow equations. Steady state conditions are rarely obtained for closed-end tubes up to several hundred miles in length. Solutions are presented for various blockage ratio vehicles with choked and unchoked flow conditions about them. Various tube lengths are also considered. The solution for a doubly infinite tube is found to be approaching the asymptotic long time solution. GRA

N75-18193*# Speas (R. Dixon) Associates, Manhasset, N.Y.
EVALUATION OF ROUTING AND SCHEDULING CONSIDERATIONS FOR POSSIBLE FUTURE COMMERCIAL HYPERSONIC TRANSPORT AIRCRAFT

Jack B. Feir [1974] 73 p refs

(Contract NAS1-13295)

(NASA-CR-132632) Avail: NTIS HC \$4.25 CSCL 01C

Travel markets which would be served by high speed commercial transport aircraft and the ability of the airlines to schedule and route the aircraft in a way that would achieve good daily utilization and productivity are examined. The following areas are considered: (1) identification of the major long-haul city pairs that would most likely demand nonstop service; (2) selection of flight tracks observing alternative sonic boom restrictions; (3) estimation of flight times for all city pairs for the various sonic boom constraints; (4) impact of airport curfews on possible departure and arrival schedules; (5) projection of passenger traffic volumes on the selected city pairs; and (6) potential daily utilization and aircraft productivity. Author

N75-18194# Applied Psychological Services, Wayne, Pa.
SURVEY OF THIN FILM FLUORESCENT MATERIAL Final Report, Jun. - Dec. 1973

Phillip J. Federman and Arthur I. Siegel Dec. 1973 72 p refs

(Contract DOT-FA73WA-3320)

(AD-A005571; FAA-RD-74-9) Avail: NTIS HC \$4.25 CSCL 11/3

The advantages and disadvantages of thin film adhesive fluorescent material for marking aircraft are discussed. Information relative to the experiences of users of this material is presented along with the most current opinions of manufacturers of the films, pigments, and adhesives from which thin film fluorescent material is constructed. Thin film fluorescent materials are compared with polyurethane paint and with fluorescent paint for marking aircraft from the points of view of added drag, added weight, and cost/utility. The analysis suggests support for the use of the thin film fluorescent materials on the basis of: possible conspicuity enhancement, minimum added weight, no differential drag effects, and a favorable cost/utility ratio. The principal disadvantage to the thin film fluorescent film appears to be its durability, although manufacturers report recent product improvements which serve to negate this objection to some extent.

Author

N75-18195*# United Air Lines, Inc., Chicago, Ill.

ENGINEERING SIMULATION DEVELOPMENT AND EVALUATION OF THE TWO-SEGMENT NOISE ABATEMENT APPROACH CONDUCTED IN THE B-727-222 FLIGHT SIMULATOR

W. E. Nylen 30 Jan. 1974 182 p

(Contract NAS2-7208)

(NASA-CR-137594) Avail: NTIS HC \$7.00 CSCL 01C

Profile modification as a means of reducing ground level noise from jet aircraft in the landing approach is evaluated. A flight simulator was modified to incorporate the cockpit hardware which would be in the prototype airplane installation. The two-segment system operational and aircraft interface logic was accurately emulated in software. Programs were developed to permit data to be recorded in real time on the line printer, a 14-channel oscillograph, and an x-y plotter. The two-segment profile and procedures which were developed are described with emphasis on operational concepts and constraints. The two-segment system operational logic and the flight simulator capabilities are described. The findings influenced the ultimate system design and aircraft interface.

Author

N75-18220*# Boeing Vertol Co., Philadelphia, Pa.

DOCUMENTING HELICOPTER OPERATIONS FROM AN ENERGY STANDPOINT

S. J. Davis and W. Z. Stepniewski Nov. 1974 127 p refs

(Contract NAS1-13142)

(NASA-CR-132578; D210-10901-1) Avail: NTIS HC \$5.75 CSCL 01C

Results are presented of a study of the relative and absolute energy consumption of helicopters, including limited comparisons with fixed-wing aircraft, and selected surface transportation vehicles. Additional comparisons were made to determine the level of reduction in energy consumption expected from the application of advanced technologies to the helicopter design and sizing process. It was found that improvements in helicopter consumption characteristics can be accomplished through the utilization of advanced technology to reduce drag, structures weight, and powerplant fuel consumption.

Author

N75-18221*# Douglas Aircraft Co., Inc., Long Beach, Calif.
ENGINE/AIRFRAME COMPATIBILITY STUDIES FOR SUPERSONIC CRUISE AIRCRAFT Final Report

Jan. 1975 254 p

(Contract NAS1-13229)

(NASA-CR-132610; MDC-J4478) Avail: NTIS HC \$8.50 CSCL 01C

Technology assessment studies were conducted to provide an updated technology base from which an advanced supersonic cruise aircraft can be produced with a high probability of

success. An assessment of the gains available through the application of advanced technologies in aerodynamics, propulsion, acoustics, structures, materials, and active controls is developed. The potential market and range requirements as well as economic factors including payload, speed, airline operating costs, and airline profitability are analyzed. The conceptual design of the baseline aircraft to be used in assessing the technology requirements is described. Author

N75-18222# National Aviation Facilities Experimental Center, Atlantic City, N.J.

THE MEASUREMENT OF THE MCDONNELL-DOUGLAS DC-9 TRAILING VORTEX SYSTEM USING THE TOWER FLY-BY TECHNIQUE Final Report

Leo J. Garodz, David Lawrence, and Nelson Miller Nov. 1974 100 p refs
(FAA Proj. 214-531-070)
(AD-A001456/3; FAA-RD-74-173; FAA-NA-74-28) Avail: NTIS HC \$4.75 CSCL 01/1

The results are presented of a series of low-altitude (approximately 200 feet above ground level) flight tests in which the trailing vortices of the McDonnell-Douglas DC9 airplane were investigated, using a 140-foot instrumented tower. Flow visualization (colored smoke streams) was employed and film records made. The airplane was tracked by a phototheodolite facility. Data presented consist of plots of vortex tangential velocity distribution, peak velocity as a function of time, airplane configuration and windspeed, vortex descent rates, and lateral transport rates. Author

N75-18223*# Massachusetts Inst. of Tech., Cambridge. Measurement Systems Lab.

SYSTEM DESIGN OF A RUDDER COORDINATION SYSTEM

H. Philip Whitaker Jan. 1975 15 p
(Grant NGL-22-009-548)
(NASA-CR-142245; RN-77) Avail: NTIS HC \$3.25 CSCL 01C

The application of the parameter optimization computer program to the design of a rudder coordination system for the F-8 airplane is summarized. The flight condition was Mach 0.56 at 20,000 feet altitude. The system configuration selected consisted of signal paths that fed yaw rate and aileron signals to the rudder. The two signal paths were summed and then modified by a high pass filter to eliminate any steady state bias signal. The input axis of the yaw gyro was perpendicular to the aircraft zero lift line and the trim angle of attack was 7.75 degrees. The parameter optimization was used to design the complete system first, and then a root locus analysis of the individual component effects was made. The results are presented. Author

N75-18224# Northrop Corp., Hawthorne, Calif. Electronics Div.

STABILIZATION OF EXTERNALLY SLUNG HELICOPTER LOADS Final Report, 1 Jul. 1972 - 31 Oct. 1973

T. C. Watkins, J. B. Sinacori, and D. F. Kesler Aug. 1974 132 p
(Contract DAAJ02-72-C-0047; DA Proj. 1F1-62207-AA-33)
(AD-A000893; USAAMRDL-TR-74-42) Avail: NTIS CSCL 15/5

Use is made of experimental data and theoretical analyses to understand why load carrying speed is limited, and an attempt is made to identify promising stabilization concepts and to determine their capability to extend carrying speed. This effort is concentrated on the 8-by-8-by-20-foot cargo container; however, implications relating to other loads are given. An attempt is made to select the appropriate combination of analysis techniques that will yield a practical solution to the problem. The motions of this load are modeled, and this model is used in an analysis of stabilization systems designed to extend the carrying speed limitations. Several stabilization concepts are explored that show promise of extending carrying speed to 200 knots. (Modified author abstract) GRA

N75-18225# Army Missile Research, Development and Engineering Lab., Redstone Arsenal, Ala. Ground Equipment/Materials Directorate.

ANALYSIS AND DESIGN OF A MULTIAxis VIBRATION ISOLATOR FOR MISSILE PODS MOUNTED ON ARMY HELICOPTERS

Edwin R. Chubbuck 19 Aug. 1974 74 p refs
(AD-A001459; RL-75-4) Avail: NTIS CSCL 01/3

A multiaxial vibration isolator for rocket launcher mounted on Army helicopter wings has been analyzed and designed; this isolator is designed to isolate vertically, in pitch, in sway from transverse translation, and in sway from roll. Air springs and hydraulic dampers are used; both have variable characteristics. Air control valves are used to sense proper position and to control air flow to and from the air springs. A small air compressor is used to produce pressurized air for the air springs. Several air chambers are used in the system. The system could be characterized by the term passive isolate/active align. GRA

N75-18226# Calspan Corp., Buffalo, N.Y.

REPORT ON PROGRAM TO IMPROVE MIL-F-83300 Final Report, Jan. 1972 - Mar. 1974

Charles R. Chalk, Robert C. Radford, and Richard Wasserman Jun. 1974 170 p refs
(Contract F33615-71-C-1722; AF Proj. 643A)
(AD-A001598; Calspan-AD-5013-F-2; AFFDL-TR-74-54) Avail: NTIS CSCL 01/3

Two experimental programs were performed: an in-flight simulation to examine STOL longitudinal characteristics, and a fixed-base simulation to study control power and control usage in hover and low-speed flight. The former experiment was accomplished by the National Research Council of Canada, and the latter by United Aircraft Research Laboratory. A limited analysis of the data obtained was performed by Calspan and recommendations were made for future experiments to expand the data base for existing and additional requirements. GRA

N75-18227# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.

THE EFFECT OF GROUND PROXIMITY ON THE LATERAL/DIRECTIONAL AERODYNAMIC AND CONTROL CHARACTERISTICS OF A TILT-WING V/STOL AIRCRAFT AT HIGH LIFT COEFFICIENTS Final Technical Report, Jan. 1971 - Aug. 1973

H. C. Curtiss, Jr., J. J. Traybar, and W. F. Putman Dec. 1973 166 p refs
(Contract F33615-71-C-1206; AF Proj. 8219)
(AD-A001584; AMS-TR-1127; AFFDL-TR-73-151) Avail: NTIS CSCL 01/1

A series of experiments was performed in the Princeton Dynamic Model Track to determine the lateral/directional stability and control of a V/STOL type aircraft in ground proximity. Of primary interest were the characteristics associated with flight at high lift coefficients and utilizing high wing incidences with large flap deflections as may be encountered during STOL operations in landings and take-offs where the full or maximum effects of ground proximity are encountered. The configurations tested included combinations of wing incidence and flap deflection up to a maximum of 60 degrees. GRA

N75-18228# AiResearch Mfg. Co., Torrance, Calif.

CATALYTIC REACTOR FOR INERTING OF AIRCRAFT FUEL TANKS Final Report, Jun. 1971 - Jun. 1974

George H. McDonald and J. Rousseau Jun. 1974 117 p refs
(Contract F33615-71-C-1901; AF Proj. 3048)
(AD-A000939; Rept-74-10294; AFAPL-TR-74-49) Avail: NTIS CSCL 01/3

The program, Catalytic Reactor for Inerting of Aircraft Fuel Tanks, was concerned with the development of a prototype catalytic reactor for the generation of inert gases through jet fuel combustion in engine bleed air. Successful operation of a flight-configured unit was achieved at very high effectiveness. Inert gas oxygen concentrations below 1 percent were achieved repeatedly. Design data were generated related to reactor performance under various operating conditions and also related

to thermal and mechanical design of the unit. Corrosion testing of aircraft fuel tank construction materials including metals, coatings, and sealants was conducted. These materials were evaluated in terms of resistance to corrosion by SO₂ formed in the fuel oxidation reactor. A complete fuel tank inerting system was synthesized. GRA

N75-18229# Florida Univ., Gainesville. Coll. of Engineering. **DESIGN ANALYSIS OF HELICOPTER AUTOMATIC AND SEMIAUTOMATIC AIRBORNE PRECISION POINTING AND TRACKING SYSTEMS** Final Report

William H. Boykin, John M. Vance, Roland C. Anderson, Gene W. Hemp, and Thomas E. Bullock Jul. 1974 105 p refs (Contract DAAH01-73-C-0978) (AD-A000834) Avail: NTIS CSCL 19/5

The report describes the research conducted into the design analysis of helicopter mounted automatic and semi-automatic airborne laser designator systems. The design goals are high line-of-sight pointing accuracy and minimum weight with realistic hardware constraints. GRA

N75-18231# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

NOISE REDUCTION STUDIES FOR THE CESSNA MODEL 337 (O-2) AIRPLANE

David A. Hilton, Andrew B. Connor, and Richard C. Dingeldein Apr. 1975 64 p ref (NASA-TM-X-72641) Avail: NTIS HC \$4.25 CSCL 01C

A study was undertaken to determine the noise reduction potential of the O-2 airplane in order to reduce its aural detection distance. Static and flyover noise measurements were made to document the noise signature of the unmodified airplane. The results show that significant reductions in aural detection distance can be achieved by the combination of propeller geometry changes and the addition of engine exhaust mufflers. The best results were estimated for the aircraft equipped with a six-blade propeller operating at 3/4 engine speed in combination with a 3.49 cubic foot exhaust muffler installed on each engine. Detection distance for the modified aircraft is estimated to be reduced from about 4-1/4 miles to about 1-1/2 miles when the aircraft is operating at an altitude of 1,000 ft over grassy terrain. Reducing the altitude to 300 ft over a leafy jungle ground cover should reduce the aural detection distance to 0.9 miles. Reduced aural detection distances were also indicated for a modification utilizing a direct-drive six-blade propeller of reduced radius along with smaller exhaust mufflers. Author

N75-18232# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

NOISE REDUCTION STUDIES FOR THE OV-1 AIRPLANE

D. A. Hilton, A. B. Connor, W. L. Copeland, and A. C. Dibble, Jr. Apr. 1975 68 p refs (NASA-TM-X-72639) Avail: NTIS HC \$4.25 CSCL 01C

A study has been conducted to define possible modifications to the OV-1 aircraft to reduce its aural detection distance. This effort involved documenting the noise characteristics of the airplane, devising modifications to reduce the noise, estimating the reduction in detection distance, and evaluating aircraft performance as a result of these modifications. It was found that the main noise source on this aircraft is the propeller and hence modifications only to the propeller and the propeller drive system are proposed. Modifications involving only the propeller are noted to involve no increase in weight but they result in only a modest decrease in aural detection distance. In order to obtain substantial decreases in aural detection distance, modifications involving changes both to the propeller and the engine-propeller gearing are required. Author

N75-18233# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

NOISE CHARACTERISTICS OF THE O-1 AIRPLANE AND SOME APPROACHES TO NOISE REDUCTION

Andrew B. Connor, David A. Hilton, W. Latham Copeland, and Lorenzo R. Clark Apr. 1975 82 p refs (NASA-TM-X-72638) Avail: NTIS HC \$4.75 CSCL 01C

A brief study of the O-1A airplane to determine possible means for reducing the aircraft aural detection distance was conducted. This effort involved measuring the noise signature of the basic airplane, devising methods to attenuate the noise, and then estimating the effect of several selected modifications on the aural detection distance of the aircraft. A relatively simple modification utilizing a 6.5 ft diameter, six-blade propeller and including a muffler having a volume of 0.725 cu ft is indicated to reduce the aural detection distance of the O-1 aircraft from about 6 miles at an altitude of 1,000 ft and 2 to 3 miles at an altitude of 300 ft to approximately half these values. The flyover noise data suggest that routing the exhaust stacks up and over the wing would provide immediate noise reduction of about 5 dB with an attendant reduction in detection distance. Furthermore, all these studies confirm the work of other investigators that the 1/3 octave band (center frequency = 125 cps) is the most critical in reducing aural detection distance. Author

N75-18234# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

GROUND NOISE MEASUREMENTS DURING STATIC AND FLYBY OPERATIONS OF THE CESSNA 02-T TURBINE POWERED AIRPLANE

David A. Hilton, Herbert R. Henderson, and Ben W. Lawton Apr. 1975 26 p refs (NASA-TM-X-72642) Avail: NTIS HC \$3.75 CSCL 01C

The field noise measurements on the Cessna 02-T turbine powered propeller aircraft are presented. The objective of the study was to obtain the basic noise characteristics of the aircraft during static ground runs and flyover tests, to identify the sources of the noise, and to correlate the noises with the aircraft operating conditions. The results are presented in the form of a overall noise levels, radiation patterns, and frequency spectra. The noise characteristics of the turbine powered aircraft are compared with those of the reciprocating engine powered aircraft. Author

N75-18235# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

NOISE REDUCTION STUDIES OF SEVERAL AIRCRAFT TO REDUCE THEIR AURAL DETECTION DISTANCES

Richard C. Dingeldein, Andrew B. Connor, and David A. Hilton Apr. 1975 50 p refs (NASA-TM-X-72644) Avail: NTIS HC \$3.75 CSCL 01C

A study was conducted to assess the extent to which practicable reductions of the external noise level of various aircraft could be achieved by different methods. The aircraft included in the study are the O-1, O-2, U-10, OV-1, and A-6. The noise signatures obtained from field measurements and the estimated aural detection distance of aircraft operating in low speed cruising flight are presented. The characteristics of each aircraft and the modifications made to reduce the aerodynamic noise are explained. Tables of data are included to show the effectiveness of the noise reduction modifications for each aircraft. Author

N75-18236# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STUDY OF THE A-6 AIRPLANE AND TECHNIQUES FOR REDUCING ITS AURAL DETECTION DISTANCE

David A. Hilton, Andrew B. Connor, and Harvey H. Hubbard Apr. 1975 44 p refs (NASA-TM-X-72643) Avail: NTIS HC \$3.75 CSCL 01C

A study was undertaken to determine the noise reduction potential of the A-6 airplane in order to reduce its aural detection distance. Static and flyby noise measurements were taken to document the basic airplane signature. The low-frequency noise which is generally most critical for aural detection was found to be broad-band in nature from this airplane, and its source is the turbojet engine exhaust. High-frequency compressor noise, which is characteristic of turbojet powerplants, and which is prominent at close range for this airplane, has no measurable effect on aural detection distance. The use of fluted-engine exhaust nozzles to change the far-field noise spectra is suggested as a possible means for reducing the aural detection distances. Detection distances associated with eight-lobe and four-lobe

nozzles are estimated for a 1,000-foot altitude and grassy terrain to decrease from 4 miles to about 3 miles, and from 3 miles to about 2 miles for a 300-foot altitude and grassy terrain. Author

N75-18237* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

TECHNOLOGY FOR REDUCING AIRCRAFT ENGINE POLLUTION

Richard A. Rudey and Erwin E. Kempke, Jr. 1975 38 p refs Presented at 1975 Business Aircraft Meeting and Eng. Display, Wichita, Kans., 9-11 Apr. 1975; sponsored by Soc. of Automotive Engr. (NASA-TM-X-71670; E-8257) Avail: NTIS HC \$3.75 CSCL 21A

Programs have been initiated by NASA to develop and demonstrate advanced technology for reducing aircraft gas turbine and piston engine pollutant emissions. These programs encompass engines currently in use for a wide variety of aircraft from widebody-jets to general aviation. Emission goals for these programs are consistent with the established EPA standards. Full-scale engine demonstrations of the most promising pollutant reduction techniques are planned within the next three years. Preliminary tests of advanced technology gas turbine engine combustors indicate that significant reductions in all major pollutant emissions should be attainable in present generation aircraft engines without adverse effects on fuel consumption. Fundamental-type programs are yielding results which indicate that future generation gas turbine aircraft engines may be able to utilize extremely low pollutant emission combustion systems.

Author

N75-18238* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE NASA RESEARCH PROGRAM ON PROPULSION FOR SUPERSONIC CRUISE AIRCRAFT

Richard J. Weber 1975 24 p Proposed for presentation at Natl. Transportation Meeting, Hartford, 6-9 May 1975; sponsored by SAE (NASA-TM-X-71666; E-8252) Avail: NTIS HC \$3.25 CSCL 21A

The objectives and status of the propulsion portion of a program aimed at advancing the technology and establishing a data base appropriate for the possible future development of supersonic cruise aircraft are reviewed. Research related to exhaust nozzles, combustors, and inlets that is covered by the noise, pollution, and dynamics programs is described.

Author

N75-18239* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

DIGITAL IMPLEMENTATION OF THE TF30-P-3 TURBOFAN ENGINE CONTROL

David S. Cwynar and Peter G. Batterton Washington Feb. 1975 55 p (NASA-TM-X-3105; E-8064) Avail: NTIS HC \$4.25 CSCL 21E

The standard hydromechanical control modes for TF30-P-3 engine were implemented on a digital process control computer. Programming methods are described, and a method is presented to solve stability problems associated with fast response dynamic loops contained within the exhaust nozzle control. A modification of the exhaust nozzle control to provide for either velocity or position servoactuation systems is discussed. Transient response of the digital control was evaluated by tests on a real time hybrid simulation of the TF30-P-3 engine. It is shown that the deadtime produced by the calculation time delay between sampling and final output is more significant to transient response than the effects associated with sampling rate alone. For the main fuel control, extended update and calculation times resulted in a lengthened transient response to throttle bursts from idle to intermediate with an increase in high pressure compressor stall margin. Extremely long update intervals of 250 msec. could be achieved without instability. Update extension for the exhaust nozzle control resulted in a delayed response of the afterburner light-off detector and exhaust nozzle overshoot with resulting

fan oversuppression. Long update times of 150 msec caused failure of the control due to a false indication by the blowout detector.

Author

N75-18240* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

IDLE EFFICIENCY AND POLLUTION RESULTS FOR TWO-ROW SWIRL-CAN COMBUSTORS HAVING 72 MODULES

James A. Biaglow and Arthur M. Trout Washington Mar. 1975 21 p refs (NASA-TM-X-3208; E-8159) Avail: NTIS HC \$3.25 CSCL 21E

Two 72-swirl-can-module combustors were investigated in a full annular combustor test facility at engine idle conditions typical of a 30:1 pressure-ratio engine. The effects of radial and circumferential fuel scheduling on combustion efficiency and gaseous pollutants levels were determined. Test conditions were inlet-air temperature, 452 K; inlet total pressure, 34.45 newtons per square centimeter; and reference velocity, 19.5 meters per second. A maximum combustion efficiency of 98.1 percent was achieved by radial scheduling of fuel to the inner row of swirl-can modules. Emission index values were 6.9 for unburned hydrocarbons and 50.6 for carbon monoxide at a fuel-air ratio of 0.0119. Circumferential fuel scheduling of two 90 degree sectors of the swirl-can arrays produced a maximum combustion efficiency of 97.3 percent. The emission index values were 12.0 for unburned hydrocarbons and 69.2 for carbon monoxide at a fuel-air ratio of 0.0130.

Author

N75-18241* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

PRELIMINARY STUDY OF ADVANCED TURBOFANS FOR LOW ENERGY CONSUMPTION

G. Knip Feb. 1975 54 p refs (NASA-TM-X-71663; E-8241) Avail: NTIS HC \$4.25 CSCL 21E

This analysis determines the effect of higher overall engine pressure ratios (OPR's), bypass ratios (BPR's), and turbine rotor-inlet temperature on a Mach-0.85 transport having a range of 5556 km (3000 nmi) and carrying a payload of 18144 kg (40,000 lbs-200 passengers). Sideline noises (jet plus fan) of between 91 and 106 EPNdB (FAR36) are considered. Takeoff gross weight (TOGW), fuel consumption (kg/pass. km) and direct operating cost (DOC) are used at the figures of merit. Based on predicted 1985 levels of engine technology and a noise goal of 96 EPNdB, the higher-OPR engine results in an airplane that is 18 percent lighter in terms of TOGW, uses 22.3 percent less fuel, and has a 14.7 percent lower DOC than a comparable airplane powered by a current turbofan. Cooling the compressor bleed air and lowering the cruise Mach number appear attractive in terms of further improving the figures of merit.

Author

N75-18242* General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.

ACOUSTIC TEST RESULTS FROM A 36 INCH (0.914m) STATORLESS LIFT FAN WITH SERRATED AND UNSERRATED ROTOR BLADES

D. L. Stimpert Jan. 1975 51 p refs (Contract NAS2-5462) (NASA-CR-137622; GE-TIS-R74AEG406) Avail: NTIS HC \$4.25 CSCL 20A

Test results of the LF336/E statorless lift fan with serrated and unserrated rotor leading edges are presented. Fan broadband noise reductions from 2 to 5 dB were achieved in the forward quadrant at frequencies from 100 to 2500 Hz. Broadband noise near and above the blade passing frequency was reduced only at angles of 80 to 100 degrees.

Author

N75-18243* Technion - Israel Inst. of Tech., Haifa. Dept. of Aeronautical Engineering.

FLUTTER SUPPRESSION AND GUST ALLEVIATION USING ACTIVE CONTROLS Semiannual Progress Report, Aug. 1974 - Jan. 1975

E. Nissim Jan. 1975 20 p refs

(Grant NSG-7072)

(NASA-CR-142195) Avail: NTIS HC \$3.25 CSCL 01C

Application of the aerodynamic energy approach to some problems of flutter suppression and gust alleviation were considered. A simple modification of the control-law is suggested for achieving the required pitch control in the use of a leading edge - trailing edge activated strip. The possible replacement of the leading edge - trailing edge activated strip by a trailing edge - tab strip is also considered as an alternate solution. Parameters affecting the performance of the activated leading edge - trailing edge strip were tested on the Arava STOL Transport and the Westwind Executive Jet Transport and include strip location, control-law gains and a variation in the control-law itself. S.S.C.

N75-18244* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

EFFECTS OF TIME-SHIFTED DATA ON FLIGHT DETERMINED STABILITY AND CONTROL DERIVATIVES

Sandra Thornberry Steers and Kenneth W. Iliff Washington Mar. 1975 86 p refs

(NASA-TN-D-7830; H-849) Avail: NTIS HC \$4.75 CSCL 01C

Flight data were shifted in time by various increments to assess the effects of time shifts on estimates of stability and control derivatives produced by a maximum likelihood estimation method. Derivatives could be extracted from flight data with the maximum likelihood estimation method even if there was a considerable time shift in the data. Time shifts degraded the estimates of the derivatives, but the degradation was in a consistent rather than a random pattern. Time shifts in the control variables caused the most degradation, and the lateral-directional rotary derivatives were affected the most by time shifts in any variable. Author

N75-18245* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

DESCRIPTION AND FLIGHT TEST RESULTS OF THE NASA F-8 DIGITAL FLY-BY-WIRE CONTROL SYSTEM

Washington Feb. 1975 196 p refs Presented at NASA Symp. on Advanced Control Technol., Los Angeles, 9-11 Jul. 1974

(NASA-TN-D-7843; H-853) Avail: NTIS HC \$7.00 CSCL 01C

A NASA program to develop digital fly-by-wire (DFBW) technology for aircraft applications is discussed. Phase I of the program demonstrated the feasibility of using a digital fly-by-wire system for aircraft control through developing and flight testing a single channel system, which used Apollo hardware, in an F-8C airplane. The objective of Phase II of the program is to establish a technology base for designing practical DFBW systems. It will involve developing and flight testing a triplex digital fly-by-wire system using state-of-the-art airborne computers, system hardware, software, and redundancy concepts. The papers included in this report describe the Phase I system and its development and present results from the flight program. Man-rated flight software and the effects of lightning on digital flight control systems are also discussed.

N75-18246* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

AN OVERVIEW OF NASA'S DIGITAL FLY-BY-WIRE TECHNOLOGY DEVELOPMENT PROGRAM

Calvin R. Jarvis In its Description and Flight Test Results of the NASA F-8 Digital Fly-by-Wire Control System Feb. 1975 p 1-12

CSCL 01C

The feasibility of using digital fly-by-wire systems to control aircraft was demonstrated by developing and flight testing a single channel system, which used Apollo hardware, in an F-8C test airplane. This is the first airplane to fly with a digital fly-by-wire system as its primary means of control and with no mechanical

reversion capability. The development and flight test of a triplex digital fly-by-wire system, which will serve as an experimental prototype for future operational digital fly-by-wire systems, is underway. Author

N75-18247* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

DESIGN AND DEVELOPMENT EXPERIENCE WITH A DIGITAL FLY-BY-WIRE CONTROL SYSTEM IN AN F-8C AIRPLANE

Dwain A. Deets In its Description and Flight Test Results of the NASA F-8 Digital Fly-by-Wire Control System Feb. 1975 p 13-40 refs

CSCL 01C

To assess the feasibility of a digital fly-by-wire system, the mechanical flight control system of an F-8C airplane was replaced with a digital system and an analog backup system. The Apollo computer was used as the heart of the primary system. This paper discusses the experience gained during the design and development of the system and relates it to active control systems that are anticipated for future civil transport applications. Author

N75-18248* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

MECHANIZATION OF AND EXPERIENCE WITH A TRIPLEX FLY-BY-WIRE BACKUP CONTROL SYSTEM

Wilton P. Lock, William R. Petersen, and Gaylon B. Whitman (Sperry Flight Systems Div.) In its Description and Flight Test Results of the NASA F-8 Digital Fly-by-Wire Control System Feb. 1975 p 41-72 refs

A redundant three-axis analog control system was designed and developed to back up a digital fly-by-wire control system for an F-8C airplane. Forty-two flights, involving 58 hours of flight time, were flown by six pilots. The mechanization and operational experience with the backup control system, the problems involved in synchronizing it with the primary system, and the reliability of the system are discussed. The backup control system was dissimilar to the primary system, and it provided satisfactory handling through the flight envelope evaluated. Limited flight tests of a variety of control tasks showed that control was also satisfactory when the backup control system was controlled by a minimum-displacement (force) side stick. The operational reliability of the F-8 digital fly-by-wire control system was satisfactory, with no unintentional downmodes to the backup control system in flight. The ground and flight reliability of the system's components is discussed. Author

N75-18249* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

THE EFFECTS OF LIGHTNING ON DIGITAL FLIGHT CONTROL SYSTEMS

J. Anderson Plumer (GE), Wilbert A. Malloy (General Motors Corp.), and James B. Craft In its Description and Flight Test Results of the NASA F-8 Digital Fly-by-Wire Control System Feb. 1975 p 73-92 refs

Present practices in lightning protection of aircraft deal primarily with the direct effects of lightning, such as structural damage and ignition of fuel vapors. There is increasing evidence of troublesome electromagnetic effects, however, in aircraft employing solid-state microelectronics in critical navigation, instrumentation and control functions. The potential impact of these indirect effects on critical systems such as digital fly-by-wire (DFBW) flight controls has been studied by several recent research programs, including an experimental study of lightning-induced voltages in the NASA F8 DFBW airplane. The results indicate a need for positive steps to be taken during the design of future fly-by-wire systems to minimize the possibility of hazardous effects from lightning. Author

and actual flight performance of the control system, assessments of aircraft flying qualities and other piloting factors, software management and control, and operational experience. Author

N75-18250* Draper (Charles Stark) Lab., Inc., Cambridge, Mass.
MAN-RATED FLIGHT SOFTWARE FOR THE F-8 DFBW PROGRAM

Robert R. Bairnsfather *In* NASA. Flight Res. Center Description and Flight Test Results of the NASA F-8 Digital Fly-by-Wire Control System Feb. 1975 p 93-126 refs

CSCL 01C

The design, implementation, and verification of the flight control software used in the F-8 DFBW program are discussed. Since the DFBW utilizes an Apollo computer and hardware, the procedures, controls, and basic management techniques employed are based on those developed for the Apollo software system. Program Assembly Control, simulator configuration control, erasable-memory load generation, change procedures and anomaly reporting are discussed. The primary verification tools--the all-digital simulator, the hybrid simulator, and the Iron Bird simulator--are described, as well as the program test plans and their implementation on the various simulators. Failure-effects analysis and the creation of special failure-generating software for testing purposes are described. The quality of the end product is evidenced by the F-8 DFBW flight test program in which 42 flights, totaling 58 hours of flight time, were successfully made without any DFCS inflight software, or hardware, failures.

Author

N75-18251* National Aeronautics and Space Administration.
 Flight Research Center, Edwards, Calif.

FLIGHT TEST EXPERIENCE WITH THE F-8 DIGITAL FLY-BY-WIRE SYSTEM

Kenneth J. Szalai *In its* Description and Flight Test Results of the NASA F-8 Digital Fly-by-Wire Control System Feb. 1975 p 127-180 refs

CSCL 01C

Flight test results of the F-8 digital fly-by-wire (DFBW) control system are presented and the implications for application to active control technology (ACT) are discussed. The F-8 DFBW system has several of the attributes of proposed ACT systems, so the flight test experience is helpful in assessing the capabilities of those systems. Topics of discussion include the predicted and actual flight performance of the control system, assessments of aircraft flying qualities and other piloting factors, software management and control, and operational experience. Author

N75-18252* National Aeronautics and Space Administration.
 Flight Research Center, Edwards, Calif.

A PILOT'S OPINION OF THE F-8 DIGITAL FLY-BY-WIRE AIRPLANE

Gary E. Krier *In its* Description and Flight Test Results of the NASA F-8 Digital Fly-by-Wire Control System Feb. 1975 p 181-195 ref

CSCL 01C

The handling qualities of the F-8 digital fly-by-wire airplane are evaluated by using the Cooper-Harper rating scale. The reasons for the ratings are given, as well as a short description of the flying tasks. It was concluded that the handling qualities of the airplane were good in most situations, although occasional ratings of unsatisfactory were given. Author

N75-18253# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE FUTURE APPLICATION OF AIRCRAFT-BORNE DIGITAL COMPUTERS IN COMPLEX-AUTOMATED ADAPTIVE CONTROL SYSTEMS FOR FLIGHT VEHICLES

E. D. Teryaev, B. M. Shamrikov, and E. A. Sergeev 15 Oct. 1974 21 p refs Transl. into ENGLISH from Inform. Mater. Akad. Nauk SSSR, Nauchnyi Sovet po Kompleksnoi Probleme (USSR), no. 6, 1972 p 19-29

(AD-A000193; FTD-MT-24-1885-74) Avail: NTIS CSCL 17/7

The functional connections are analyzed in the construction of integrated control systems which use both special purpose and general purpose airborne computers. Considered are federative, centralized, and hybrid systems and their advantages and disadvantages. G.G.

N75-18254# National Aeronautical Establishment, Ottawa (Ontario).

THE FLIGHT INVESTIGATION AND ANALYSIS OF LONGITUDINAL HANDLING QUALITIES OF STOL AIRCRAFT ON LANDING APPROACH Final Report, Jul. 1972 - May 1974

Karl-H. Doetsch, Jr. and Douglas W. Laurie-Lean Mar. 1974 317 p refs

(Contract F33615-71-C-1722)

(AD-A001596; NAE-LTR-FR-42; AFFDL-TR-74-18) Avail: NTIS CSCL 01/1

A flight investigation was undertaken of the longitudinal handling qualities of the STOL class of aircraft controlled through the modulation of pitch and normal thrust, and flown on steep instrument landing approaches at low airspeed. Pilots' assessments of the characteristics resulting from independent variations in both short and long term longitudinal dynamics were obtained. It was found that the pitch control characteristics dominated the handling qualities. The more easily and precisely pitch could be controlled, the more adverse the control characteristics of the other degrees of freedom the pilot would accept. When precise long-term control of airspeed through pitch modulation was not difficult, the pilots were prepared to tolerate operation well along the backside of the power-required curve.

GRA

N75-18259# National Aviation Facilities Experimental Center, Atlantic City, N.J.

EVALUATION OF A HIGH-CAPACITY, FIREFIGHTING FOAM-DISPENSING SYSTEM Final Report, Sep. - Oct. 1973

George B. Geyer, Lawrence M. Neri, and Charles H. Urban Jan. 1975 46 p refs

(FAA Proj. 081-431-020)

(AD-A006264; FAA-RD-74-204; FAA-NA-74-19) Avail: NTIS HC \$3.75 CSCL 01E

A series of tests was conducted using a single barrel mechanical foam nozzle discharging 1,800 gallons of foam solution per minute. Experiments were conducted with protein foam and with aqueous-firm-forming-foam. The tests were designed to dispense foam solution at a fixed rate in simulated full-scale fire-modeling experiments in which the fire area was smaller than the total area of foam application, thereby conserving fuel and reducing atmospheric contamination. The time required to foam-cover concentric circular diked areas of 12,000, 18,000, and 36,000 square feet containing a three-dimensional fire in a 2,827 square foot fire-pool was determined. The foam quality and ground patterns produced by each agent were determined for solution rates of 840 and 1,800 gallons per minute. Author

N75-18263# Systems Consultants, Inc., San Diego, Calif.

DEVELOPMENT OF A NON-SURVEY METHOD ESTIMATING TRAFFIC AT NONTOWERED AIRPORTS Final Report

Bruce Brown Nov. 1974 163 p

(Contract DOT-FA72WA-2774)

(AD-A002397; SCI-4013; FAA-RD-74-177) Avail: NTIS HC \$6.25 CSCL 01/5

A method for estimating the annual levels of itinerant, local, and total operations at non-towered airports is discussed. The procedure is centered about a mathematical formula that relates airport operations as a function of the airport characteristics and those of the surrounding community. In addition, a method is developed for estimating peak hour and peak day operation levels. The mathematical models and the parameters used in conducting the evaluation are presented. Charts of data are provided for the airports which were involved in the study.

Author

N75-18266# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

WALL CORRECTIONS IN TRANSONIC SQUARE TEST SECTIONS WITH PERFORATED WALLS. INFLUENCE OF THE MODEL SPAN ON LIFT CORRECTIONS

X. Vaucheret 10 Sep. 1974 36 p refs Transl. into ENGLISH from Rech. Aerospatiale (Chatillon-sous-Bagneux), Apr. 1974 p 1-27

(AD-A000138; FTD-HC-23-2806-74) Avail: NTIS CSCL 14/2

The dimensions of models which are compatible with criteria such as the wall correction criteria can be tolerated compared with the measurement dispersions and only blockage corrections must be considered. For example, in a square test section with perforated horizontal walls, the obstructions which follow from the proposed criteria are 8% at Mach 0.95 and 1.3% at Mach 0.8. In the case of large span models, such obstruction values correspond to high ratios of the model span and section width. These ratios for a model type, such as the transonic transport having a span close to 7, are 0.65 at Mach 0.95 and 0.85 and Mach 0.80. Under these conditions, it is important to correctly describe the wing and, in particular, the lift distribution over the span in order to calculate the lift correction coefficients. GRA

N75-18971*# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.

ACOUSTIC TRANSMISSION THROUGH A FUSELAGE SIDEWALL

J. F. Wilby and T. D. Scharton [1973] 79 p refs

(Contract NAS1-11839)

(NASA-CR-132602; Rept-2742) Avail: NTIS HC \$4.75 CSCL 20A

A definition is given of an idealized fuselage sidewall structure and a simplified analytical model for determining acoustical transmission from the exterior to the interior of a fuselage was constructed. The representation of the sidewall structure chosen for the analytical model excludes complicating effects such as cabin pressurization, acoustic transmission through windows or door seal leaks, aerodynamic excitation, and structural vibration excitation of the fuselage skin. Author

N75-18976# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

NEAR FIELD NOISE PREDICTION FOR A LINEAR ARRAY OF TURBOJET ENGINES Final Report

D. L. Smith, R. P. Paxson, R. D. Talmadge, and G. A. Plzak Jul. 1974 79 p refs

(AF Proj. 1471)

(AD-A001329; AFFDL-TM-74-139-FYA) Avail: NTIS CSCL 20/1

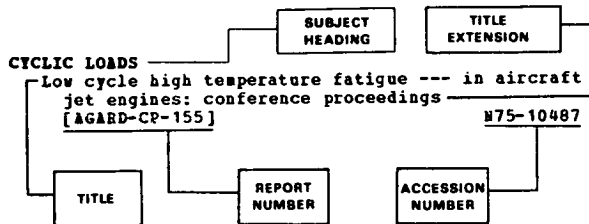
A computer program is presented for calculating the sound pressure level (SPL) in the jet near field which accounts for ground reflection and multiple engine operation. The prediction method is a modification of the semi-empirical technique presented in AFFDL TR-67-43 'Near Field Noise Analysis of Aircraft Propulsion Systems with emphasis on Prediction Techniques for Jets'. The modifications in addition to accounting for ground reflection allow the prediction of the SPL for the overall and three octave bands at any point in the field and require data inputs of jet exit temperature, Mach number and diameter. A brief description is presented of a noise measurement program conducted on the XB-70 aircraft during which one-third octave band noise spectra were obtained for a range of engine conditions and for various combinations of linear arrays of engines. GRA

SUBJECT INDEX

AERONAUTICAL ENGINEERING /A Special Bibliography (Suppl. 58)

JUNE 1975

Typical Subject Index Listing



The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of the document content, a title extension is added, separated from the title by three hyphens. The NASA or AIAA accession number is included in each entry to assist the user in locating the abstract in the abstract section of this supplement. If applicable, a report number is also included as an aid in identifying the document.

A

A-6 AIRCRAFT

A noise study of the A-6 airplane and techniques for reducing its aural detection distance
[NASA-TN-X-72643] W75-18236

AC GENERATORS

VSCF starter generator --- variable speed constant frequency cycloconverter for aircraft applications
A75-23594

ACCELERATION (PHYSICS)

Problems and implementation possibilities of a direct side force control in the case of fighters
[DGLR PAPER 74-84] A75-24140

ACCELERATION TOLERANCE

Vertical seeking ejection seat
A75-25053

ACCELEROMETERS

Statistical review of counting accelerometer data for Navy and Marine fleet aircraft
[AD-A000092] W75-17355

ACCESSORIES

Automatic Test System Jet Engine Accessories
A75-23649

ACOUSTIC ATTENUATION

Propagation of sound in elliptic ducts
A75-22791

Sound propagation in curved ducts
[AIAA PAPER 75-497] A75-25766

Acoustic wave propagation in a lined duct with non-uniform admittance
[AIAA PAPER 75-515] A75-25781

Propagation of aircraft noise over long distances through the lower atmosphere
[AIAA PAPER 75-542] A75-25804

ACOUSTIC DUCTS

Propagation of sound in elliptic ducts
A75-22791

Influence of grazing flow on duct wall normal impedances --- for noise reduction
[AIAA PAPER 75-494] A75-25763

Sound propagation in curved ducts
[AIAA PAPER 75-497] A75-25766

Sparse matrix techniques applied to modal analysis of multi-section duct liners
[AIAA PAPER 75-514] A75-25780

Acoustic wave propagation in a lined duct with non-uniform admittance
[AIAA PAPER 75-515] A75-25781

Computational methods for acoustic radiation from circular ducts
[AIAA PAPER 75-516] A75-25782

Effects of a conical segment on sound radiation from a circular duct
[AIAA PAPER 75-517] A75-25783

Generalized wave envelope analysis of sound propagation in ducts with stepped noise source profiles and variable axial impedance
[AIAA PAPER 75-518] A75-25784

ACOUSTIC IMPEDANCE

Influence of grazing flow on duct wall normal impedances --- for noise reduction
[AIAA PAPER 75-494] A75-25763

Generalized wave envelope analysis of sound propagation in ducts with stepped noise source profiles and variable axial impedance
[AIAA PAPER 75-518] A75-25784

Review of theory and methods for the prediction of ground effects on aircraft noise propagation
[AIAA PAPER 75-538] A75-25800

ACOUSTIC MEASUREMENTS

V/STOL rotor and propeller noise - Its prediction and analysis of its aural characteristics
[AIAA PAPER 75-452] A75-25734

Scrubbing noise of externally blown flaps
[AIAA PAPER 75-469] A75-25745

Experimental investigation of the aeroacoustic characteristics of model slot nozzles with straight flaps
[AIAA PAPER 75-471] A75-25746

Ambient and induced pressure fluctuations in supersonic jet flows --- acoustic tracing of noise source
[AIAA PAPER 75-482] A75-25754

Outdoor jet noise facility, a unique approach
[AIAA PAPER 75-530] A75-25792

Aircraft flyover noise measurements
[AIAA PAPER 75-537] A75-25799

Some questions on the creation of an open stand for acoustic investigations of DTRD's --- development of facilities for testing turbofan engines
[AD-A000660] W75-17365

Prediction of airframe noise
[NASA-TN-D-7821] W75-18182

Noise reduction studies for the Cessna model 337 (0-2) airplane
[NASA-TN-X-72641] W75-18231

Noise reduction studies for the OV-1 airplane
[NASA-TN-X-72639] W75-18232

Noise characteristics of the O-1 airplane and some approaches to noise reduction
[NASA-TN-X-72638] W75-18233

Ground noise measurements during static and flyby operations of the Cessna 02-T turbine powered airplane
[NASA-TN-X-72642] W75-18234

Noise reduction studies of several aircraft to reduce their aural detection distances
[NASA-TN-X-72644] W75-18235

A noise study of the A-6 airplane and techniques for reducing its aural detection distance
[NASA-TN-X-72643] W75-18236

Near field noise prediction for a linear array of turbojet engines
[AD-A001329] W75-18976

ACOUSTIC PROPAGATION

Generalized aerodynamic noise equation
A75-24418

Review of theory and methods for the prediction of ground effects on aircraft noise propagation
[AIAA PAPER 75-538] A75-25800

ACOUSTIC PROPERTIES

Broadband noise generated by turbulent inflow to rotor or stator blades in an annular duct
[NASA-CR-2503] W75-17361

- Some questions on the creation of an open stand for acoustic investigations of DTRD's --- development of facilities for testing turbofan engines
[AD-A000660] N75-17365
- Noise reduction studies of several aircraft to reduce their aural detection distances
[NASA-TM-X-72644] N75-18235
- ACOUSTIC SCATTERING**
The scattering of sound by a vortex sheet
A75-22934
- ACOUSTIC SIMULATION**
Acoustic characteristics of a large upper-surface blown configuration with turbofan engines
[AIAA PAPER 75-473] A75-25748
- Noise shielding effects for engine-over-wing installations
[AIAA PAPER 75-474] A75-25749
- ACOUSTICS**
Acoustic test results from a 36 inch (0.914m) statorless lift fan with serrated and unserrated rotor blades
[NASA-CR-137622] N75-18242
- ACTUATORS**
Aircraft control surface actuators --- Russian book
A75-23423
- ADAPTIVE CONTROL**
The future application of aircraft-borne digital computers in complex-automated adaptive control systems for flight vehicles
[AD-A000193] N75-18253
- AERIAL RECONNAISSANCE**
Problems in the integration of infrared line scanners in high-performance aircraft
[DGLR PAPER 74-94] A75-24143
- Remotely piloted LTA vehicle for surveillance
A75-26028
- AERIAL RUDDERS**
On empennage stability --- aircraft control surface deflection
A75-23802
- AERODYNAMIC BALANCE**
Method of balancing VTOL aircraft
[SAWE PAPER SWR 7] A75-24348
- AERODYNAMIC CHARACTERISTICS**
Transonic wing design and its effects on flight performance
[DGLR PAPER 74-97] A75-24144
- Approximate solution of integral equations with a singular operator --- for wing motion
A75-24835
- The significance of aerodynamic jet interference in development and testing of the Do 31 V/STOL transport
[NASA-TT-F-16165] N75-17335
- AERODYNAMIC COEFFICIENTS**
Ice simulation: A 2-dimensional wind tunnel investigation of a NACA 652A215 wing section with single slotted flap. Part 2: Configurations typical for transport airplanes
[PFA-TN-AU-995-PT-2] N75-17309
- Conversion factor for profile drag increment for part-span flaps
[ESDU-FLAPS-02.01.07] N75-18173
- AERODYNAMIC CONFIGURATIONS**
FAA JT3D quiet nacelle retrofit feasibility program. Volume 3: Lower goal flight testing, economic analyses and summary
[AD-787610] N75-17334
- Conversion factor for profile drag increment for part-span flaps
[ESDU-FLAPS-02.01.07] N75-18173
- Application of numerical optimization to the design of low speed airfoils
[NASA-TM-X-3213] N75-18181
- Prediction of airframe noise
[NASA-TN-D-7821] N75-18182
- Aerodynamic design and analysis system for supersonic aircraft. Part 1: General description and theoretical development
[NASA-CR-2520] N75-18185
- Aerodynamic design and analysis system for supersonic aircraft. Part 3: Computer program description
[NASA-CR-2522] N75-18186
- Engine/airframe compatibility studies for supersonic cruise aircraft
[NASA-CR-132610] N75-18221
- Noise reduction studies of several aircraft to reduce their aural detection distances
[NASA-TM-X-72644] N75-18235
- AERODYNAMIC DRAG**
The effect of initial values on wing form and the limiting curve of the wave drag coefficients of optimized symmetrical-thick delta wings in supersonic flow
A75-23100
- Induced drag effect on airframe noise
[AIAA PAPER 75-487] A75-25757
- Boundary layer control for airships
A75-25983
- Transonic wind tunnel tests on two-dimensional aerofoil sections Part 1: Determination of pressure distribution and drag for an aerofoil of type NLR 13 in PFA wind tunnel S5
[PFA-TN-AU-725-PT-1] N75-17299
- Effects of nozzle interfairing modifications on longitudinal aerodynamic characteristics of a twin jet, variable wing sweep fighter model
[NASA-TN-D-7817] N75-18180
- AERODYNAMIC FORCES**
Unsteady flow through a turbomachine stage with free vortex shed
A75-23945
- Approximate solution to the wing theory equation by the Bubnov-Galerkin method
A75-24833
- The planar dynamics of airships
A75-25986
- AERODYNAMIC HEATING**
Influence of velocity, impingement angle, heating, and aerodynamic shock layers on erosion of materials at velocities of 5500 ft per s /1700 m per s/
A75-25188
- Aerodynamic heating of supersonic blunt bodies
[AD-A001135] N75-18190
- AERODYNAMIC LOADS**
Contribution to the study of supercritical profile flow
[DGLR PAPER 74-99] A75-24146
- An aerodynamic load criterion for airships
A75-25985
- Wind tunnel investigation of aerodynamic loads on a large-scale externally blown flap model and comparison with theory
[NASA-TN-D-7863] N75-17294
- AERODYNAMIC NOISE**
Generalized aerodynamic noise equation
A75-24418
- Recent advances in the technology of aircraft noise control
[AIAA PAPER 75-317] A75-25014
- Tests of a theoretical model of jet noise --- based on Lighthill-Ribner theory
[AIAA PAPER 75-436] A75-25723
- New evidence of subsonic jet noise mechanisms
[AIAA PAPER 75-437] A75-25724
- Turbine noise generation, reduction and prediction
[AIAA PAPER 75-449] A75-25731
- Noise of high speed rotors --- theory for propeller and helicopter configurations
[AIAA PAPER 75-450] A75-25732
- Discrete frequency rotor noise --- from helicopters
[AIAA PAPER 75-451] A75-25733
- Thickness noise of helicopter rotors at high tip speeds
[AIAA PAPER 75-453] A75-25735
- The development of experimental techniques for the study of helicopter rotor noise
[AIAA PAPER 75-455] A75-25736
- Measurements of static inlet turbulence --- for turbofan engines
[AIAA PAPER 75-467] A75-25743
- Scrubbing noise of externally blown flaps
[AIAA PAPER 75-469] A75-25745
- Experimental investigation of the aeroacoustic characteristics of model slot nozzles with straight flaps
[AIAA PAPER 75-471] A75-25746
- Forward velocity effects on under-the-wing externally blown flap noise
[AIAA PAPER 75-476] A75-25750
- Experiments on supersonic jet noise
[AIAA PAPER 75-478] A75-25751

- Ambient and induced pressure fluctuations in supersonic jet flows --- acoustic tracing of noise source
[AIAA PAPER 75-482] A75-25754
- Diagnostic calculations of airframe-radiated noise
[AIAA PAPER 75-485] A75-25755
- Aircraft far-field aerodynamic noise - Its measurement and prediction
[AIAA PAPER 75-486] A75-25756
- Induced drag effect on airframe noise
[AIAA PAPER 75-487] A75-25757
- Measurements of discrete vortex noise in a closed-throat wind tunnel
[AIAA PAPER 75-488] A75-25758
- Trailing edge noise --- generated by oscillatory flow on flat plate
[AIAA PAPER 75-489] A75-25759
- Cross-correlation of noise produced inside a hot turbojet exhaust with and without suppression using a new, hot probe
[AIAA PAPER 75-505] A75-25771
- Noise radiation from turbulent flows over compliant surfaces
[AIAA PAPER 75-507] A75-25773
- Measurements and analysis of aircraft airframe noise
[AIAA PAPER 75-510] A75-25776
- An experimental study of airframe self-noise
[AIAA PAPER 75-511] A75-25777
- Computational methods for acoustic radiation from circular ducts
[AIAA PAPER 75-516] A75-25782
- Core engine noise due to temperature fluctuations convecting through turbine blade rows
[AIAA PAPER 75-528] A75-25791
- Outdoor jet noise facility, a unique approach
[AIAA PAPER 75-530] A75-25792
- Methods for the prediction of airframe aerodynamic noise
[AIAA PAPER 75-539] A75-25801
- FAA JT3D quiet nacelle retrofit feasibility program. Volume 3: Lower goal flight testing, economic analyses and summary
[AD-787610] N75-17334
- Static and wind tunnel model tests for the development of externally blown flap noise reduction techniques
[NASA-CR-134675] N75-18177
- Prediction of airframe noise
[NASA-TN-D-7821] N75-18182
- AERODYNAMIC STABILITY**
- Fly-by-wire delta-canard configurations save weight
[SAWE PAPER SWR 3] A75-24345
- Ejection seat steering and control
A75-25067
- Boundary layer control for airships
A75-25983
- Airship stresses due to vertical velocity gradients and atmospheric turbulence
A75-25984
- Design aspects of zeppelin operations from case histories
A75-25994
- Comparison between dynamic stability boundaries for NPL 9615 and NACA 0012 aerofoils pitching about the quarter-chord
[ARC-CP-1279] N75-17302
- Mechanical instability ground dynamics program
[AD-A001101] N75-17349
- Input design for identification of aircraft stability and control derivatives
[NASA-CR-2493] N75-17370
- Methods for predicting the aerodynamic and stability and control characteristics of STOL aircraft. Volume 1: Basic theoretical methods
[AD-A001580] N75-17375
- Methods for predicting the aerodynamic and stability and control characteristics of STOL aircraft. Volume 2: STOL aerodynamic methods computer program
[AD-A001581] N75-17376
- Methods for predicting the aerodynamic and stability and control characteristics of STOL aircraft. Volume 3: Engineering methods
[AD-A001582] N75-17377
- Stabilization of externally slung helicopter loads
[AD-A000893] N75-18224
- Effects of time-shifted data on flight determined stability and control derivatives
[NASA-TN-D-7830] N75-18244
- AERODYNAMIC STALLING**
- Report on spin test of AJ37 Viggen
A75-24807
- Comparison between dynamic stability boundaries for NPL 9615 and NACA 0012 aerofoils pitching about the quarter-chord
[ARC-CP-1279] N75-17302
- Stall flutter and nonlinear divergence of a two-dimensional flat plate wing
[AD-A000569] N75-17314
- Instrumentation and control system for an F-15 stall/spin
[NASA-TM-X-72647] N75-17353
- AERODYNAMICS**
- The aerodynamics of vehicles in finite length tubes
[PB-236692/0] N75-18192
- AEROELASTICITY**
- Calculation of flutter boundary of dynamically nonuniform profile cascades
A75-23819
- A finite element approach to the aeroelastic analysis of lifting surface type structures
A75-24918
- Aeroelasticity of plates and shells --- Book
A75-25180
- AERONAUTICAL ENGINEERING**
- Handbook for aircraft mechanics /3rd revised and enlarged edition/
A75-23366
- Supercritical wing sections 2, volume 108
[NASA-CR-142229] N75-18167
- AERONAUTICAL SATELLITES**
- Aero-marine communications by satellite
A75-24100
- AEROSAT test and evaluation avionics --- aeronautical satellite communication system for oceanic ATC
A75-26043
- AERONAUTICS**
- An integrated PCM data system for full scale aeronautics testing --- common data bases for user requirements
A75-23902
- AEROSOLS**
- Possible climatic effects of supersonic transports
A75-23973
- AEROSPACE ENGINEERING**
- Aerospace technology - Planning methodology and defense-technological objectives
[DGLR PAPER 74-67] A75-24130
- AEROSPACE ENVIRONMENTS**
- 1974 report to the aerospace profession; Proceedings of the Eighteenth Symposium, Beverly Hills, Calif., September 25-28, 1974
A75-24802
- AEROSPACE INDUSTRY**
- The technology of the aircraft MRCA and its systems
[DGLR PAPER 74-63] A75-24129
- AEROSPACE SYSTEMS**
- The future of real time telemetry systems --- for computerized testing of aerospace vehicles
A75-23889
- AEROSPACE VEHICLES**
- Trends in aerospace vehicle design
[SAWE PAPER SWR 4] A75-24346
- Simulation of hypersonic scramjet exhaust --- pressure distribution on afterbody/nozzle sections of vehicle
[NASA-CR-2494] N75-17344
- AFTERBODIES**
- Recent progress in experimental studies of afterbodies
A75-24943
- AIR CARGO**
- Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings
A75-25969
- An approach to market analysis for lighter than air transportation of freight
A75-25979
- Method for transporting impellent gases
A75-26001
- Airships for transporting highly volatile commodities --- compared with ocean tankers and gas pipelines
A75-26017

AIR CONDITIONING

SUBJECT INDEX

Aerocrane - A hybrid LTA aircraft for aerial crane applications
A75-26019

AIR CONDITIONING
Exploitation of air conditioning systems for passenger aircraft --- Russian book
A75-23375

AIR COOLING
Thermodynamics of multistage air-cooled gas turbine
A75-23817

AIR FLOW
Characteristics of air bearings with small inlet holes for a precision coordinate measuring device
A75-25715
Effect of geometry on open cavity flow-induced pressure oscillations
[AIAA PAPER 75-492]
A75-25761

AIR JETS
The near field sound pressures of a choked jet when oscillating in the spinning mode
[AIAA PAPER 75-479]
A75-25752

AIR NAVIGATION
Aids to air navigation
A75-23349
Theory of astronomical correction --- Russian book on celestial navigation of flight vehicles
A75-23395

AIR POLLUTION
Hydrocarbon emissions from jet engines operated at simulated high-altitude supersonic flight conditions
A75-23963
Emission calibration of a J-58 afterburning turbojet engine at simulated supersonic, stratospheric flight conditions
A75-23964
Stratospheric pollution - Aircraft engine emissions in the region above the tropopause as a function of aircraft altitude and tropopause height
A75-23965
Possible climatic effects of supersonic transports
A75-23973
Design of low-pollution burners
A75-24945
Engineering and development program plan: Aircraft propulsion systems air pollution
[AD-777484]
N75-17835
Technology for reducing aircraft engine pollution
[NASA-TM-X-71670]
N75-18237
Idle efficiency and pollution results for two-row swirl-can combustors having 72 modules
[NASA-TM-X-3208]
N75-18240

AIR TRAFFIC
Aircraft noise in a high-rise city
A75-24000
Development of a non-survey method estimating traffic at nontowered airports
[AD-A002397]
N75-18263

AIR TRAFFIC CONTROL
The institutionalization and the general problems of air traffic
A75-23348
Performance survey of the air traffic control radar beacon system
A75-23459
Forecasting traffic in an air transport network
A75-24341
Decision-making model for ATC system improvement
A75-24754
A flight research program to develop airborne systems for improved terminal area operations
A75-24803
Air traffic control
A75-25861
The use of digital computers in air traffic control
A75-25862
Laterally displaced ISLS antenna for tactical radar --- Interrogation Side Lobe Suppression
A75-25926
Surveillance velocity measurements with least maximum error
A75-25928
Advanced signal processing for airport surveillance radars
A75-26037

AEROSAT test and evaluation avionics --- aeronautical satellite communication system for oceanic ATC
A75-26043

An overview of the upgraded third generation air traffic control system
A75-26059
Status of the wake vortex avoidance system --- in terminal airspace
A75-26060
DABS - Projected performance and experimental results --- Discrete Address Beacon System for ATC
A75-26061
Ground-based collision avoidance systems for air traffic
A75-26062
Test bed for the upgraded third generation Air Traffic Control System
A75-26064
Study of alternative beacon based surveillance and data link systems, volume 2
[AD-772136]
N75-17325
ATC surveillance/communication analysis and planning --- including ASR radar, beacon interference locator, and transponder analyzer
[AD-783184]
N75-17326
Evaluation of routing and scheduling considerations for possible future commercial hypersonic transport aircraft
[NASA-CR-132632]
N75-18193

AIR TRANSPORTATION
Connection between the flight plan and the repair hangar control plan and its meaning for the quality of the transport process
A75-23043
A solution to the transport of exceptionally large loads - The dirigible
A75-23199
Forecasting traffic in an air transport network
A75-24341
Process of selection and quantization in the case of the fleet of Iberia
A75-25863
Preliminary estimates of operating costs for lighter than air transports
A75-25972
An approach to market analysis for lighter than air transportation of freight
A75-25979
Operational considerations for the airship in short-haul transportation
A75-25993
Lighter than air - A look at the past, a look at the possibilities
A75-25995
The Slate all metal airship --- design and historical survey
A75-25998
A semibuoyant vehicle for general transportation missions
A75-26006
Some aspects of Hybrid-Zeppelins --- with slender delta wing
A75-26008
The variable density aircraft concept
A75-26010
The application of the airship to regions lacking in transport infrastructure
A75-26012
Using lighter than air vehicles /dirigibles/ in housing construction
A75-26018
Two lighter than air systems in opposing flight regimes - An unmanned short haul, heavy load transport balloon and a manned, light payload airship
A75-26025

AIRBORNE EQUIPMENT
A flight research program to develop airborne systems for improved terminal area operations
A75-24803

AIRBORNE/SPACEBORNE COMPUTERS
The future application of aircraft-borne digital computers in complex-automated adaptive control systems for flight vehicles
[AD-A000193]
N75-18253

SUBJECT INDEX

AIRCRAFT DESIGN

AIRCRAFT ACCIDENT INVESTIGATION

Aircraft accident reports. Brief format supplemental issue, 1973 accidents. File numbers 1-0040 thru 1-0042, 3-4141 thru 3-4163, 4-0001 thru 4-0032, 5-0001 thru 5-0035, 6-0001 thru 6-0086, A-0001 thru A-0003, A-0005, C-0001, E-0001 thru E-0023
[PB-237091/4] N75-17322

AIRCRAFT ACCIDENTS

Emergency and disaster plans, and associated problems concerning major aircraft accidents A75-25069
General aviation safety - Fact and fiction A75-25719

Aircraft accident reports. Brief format supplemental issue, 1973 accidents. File numbers 1-0040 thru 1-0042, 3-4141 thru 3-4163, 4-0001 thru 4-0032, 5-0001 thru 5-0035, 6-0001 thru 6-0086, A-0001 thru A-0003, A-0005, C-0001, E-0001 thru E-0023
[PB-237091/4] N75-17322

AIRCRAFT APPROACH SPACING

Surveillance velocity measurements with least maximum error A75-25928

AIRCRAFT CARRIERS

Surface effect takeoff and landing system (SETOLS) [AD-A000101] N75-17345

AIRCRAFT COMMUNICATION

Data transmission by optical fibers aboard aircraft A75-23855
Aeroflight communications and RF nav aids --- for space shuttle orbiters A75-23912

AEROSAT test and evaluation avionics --- aeronautical satellite communication system for oceanic ATC A75-26043

DABS - Projected performance and experimental results --- Discrete Address Beacon System for ATC A75-26061

AIRCRAFT CONFIGURATIONS

Method of balancing VTOL aircraft [SAFE PAPER SWR 7] A75-24348
Recent wake turbulence flight test programs A75-24805
The shape of the future long-haul transport airplane [AIAA PAPER 75-305] A75-25012
Effect of geometry on open cavity flow-induced pressure oscillations [AIAA PAPER 75-492] A75-25761
An experimental study of airframe self-noise [AIAA PAPER 75-511] A75-25777
The planar dynamics of airships A75-25986
The Airfloat HL project --- heavy lift airship A75-26004
The Dynairship --- deltoid aerobody combining buoyant and dynamic lift A75-26007
Ultra-heavy vertical lift system 'The Heli-Stat' --- combined LTA-helicopter design A75-26009

AIRCRAFT CONTROL

AFTI TI-1 program --- Advanced Fighter Technology Integration [SAE PAPER 740860] A75-22939
F-4/CCV-flight tests of advanced technology [SAE PAPER 740861] A75-22940
Aircraft control surface actuators --- Russian book A75-23423
A state-variable design approach for a high-performance aerospace vehicle pitch orientation system with variable coefficients A75-23457
Control, stabilization, and guidance of flight vehicles [DGLR PAPER 74-75] A75-24133
The devising of control systems with the help of computer-aided design and their application [DGLR PAPER 74-78] A75-24135
A controller of variable structure for the reduction of the complexity of flight control systems [DGLR PAPER 74-79] A75-24136
Design of a guided flight vehicle according to viewpoints of probability theory, taking into account perturbation and control parameters [DGLR PAPER 74-80] A75-24137

Problems and implementation possibilities of a direct side force control in the case of fighters [DGLR PAPER 74-84] A75-24140
Modern control - Modeling and application in real aircraft flight control system design A75-24758

YP-16 flight test program - Lightweight fighter program A75-24808

Manual control system design using a dual suboptimal control model A75-24839

Electrostatic vertical sensing and control concept for aircraft escape systems A75-25068

Multilevel control optimization using subsystem relative performance index sensitivity A75-25098

Air traffic control A75-25861

VTOL flight-control system design using sensitivity analysis A75-25879

Analysis and preliminary design of an advanced technology transport flight control system [NASA-CR-2490] N75-17295

Input design for identification of aircraft stability and control derivatives [NASA-CR-2493] N75-17370

Flight control systems properties and problems, volume 1 [NASA-CR-2500] N75-17371

Flight control systems properties and problems. Volume 2: Block diagram compendium [NASA-CR-2501] N75-17372

VTOL airplane control in transition regimes [AD-A000128] N75-17378

Flutter suppression and gust alleviation using active controls [NASA-CR-142195] N75-18243

Description and flight test results of the NASA F-8 digital fly-by-wire control system [NASA-TN-D-7843] N75-18245

An overview of NASA's digital fly-by-wire technology development program N75-18246

Design and development experience with a digital fly-by-wire control system in an F-8C airplane N75-18247

Mechanization of and experience with a triplex fly-by-wire backup control system N75-18248

The effects of lightning on digital flight control systems N75-18249

Man-rated flight software for the F-8 DPBW program N75-18250

Flight test experience with the F-8 digital fly-by-wire system N75-18251

A pilot's opinion of the F-8 digital fly-by-wire airplane N75-18252

AIRCRAFT DESIGN

Advanced composite design concepts for the AMST [SAE PAPER 740870] A75-22944

Stress analysis of aircraft fuselages and pressurized cabins --- Russian book A75-23231

The Il-18 aircraft /2nd enlarged and revised edition/ --- Russian book A75-23421

S-3A Design-to-a-Cost program [SME PAPER MM74-710] A75-23439

Cost-competitive B-1 composite secondary structures [SME PAPER EM74-732] A75-23443

Substantiation of discrete-continuum low-aspect-ratio wing structural analysis scheme A75-23798

Digital avionics - An established technology A75-24049

The technology of the aircraft MRCA and its systems [DGLR PAPER 74-63] A75-24129

Development trends in aircraft design --- economic analysis [DGLR PAPER 74-68] A75-24131

AIRCRAFT DETECTION

SUBJECT INDEX

Design of a guided flight vehicle according to viewpoints of probability theory, taking into account perturbation and control parameters [DGLR PAPER 74-80] A75-24137

Development and wind tunnel investigation of three supercritical airfoil profiles for transport aircraft [DGLR PAPER 74-100] A75-24147

RTOL and steep approach - Why [DGLR PAPER 74-112] A75-24152

Development and use of types of construction employing fiber-reinforced materials --- German book on aircraft materials [DGLR PAPER 74-117] A75-24154

The Alpha-Jet spoiler of carbon-epoxy material [DGLR PAPER 74-119] A75-24156

Development of the inlet ramp of a supersonic aircraft, employing a design which utilizes a fiber composite material [DGLR PAPER 74-120] A75-24157

Development of a VFW-614 spoiler in a design utilizing boron fiber reinforced plastic [DGLR PAPER 74-121] A75-24158

Trends in aerospace vehicle design [SAWE PAPER SWR 4] A75-24346

Method of balancing VTOL aircraft [SAWE PAPER SWR 7] A75-24348

Concorde inlet system and peripheral envelope flight testing A75-24804

P-15 update report A75-24806

YP-16 flight test program - Lightweight fighter program A75-24808

YP-17 flight test program - Lightweight fighter program A75-24809

Aerodynamics of the propellers of rapidly convertible VTOL aircraft A75-24942

NASA general aviation technology programs [AIAA PAPER 75-290] A75-25007

The shape of the future long-haul transport airplane [AIAA PAPER 75-305] A75-25012

NASA's role in aeronautics A75-25713

The effects of selected modern technological concepts on the performance and handling characteristics of LTA vehicles A75-25982

Long fluid filled bags suspended by line forces --- for airship design A75-25988

Potential contribution of high strength, high modulus aramid fibers to the commercial feasibility of lighter than air craft A75-25992

The Slate all metal airship --- design and historical survey A75-25998

The aerospace developments concept --- airship design for natural gas transport A75-26000

The design and construction of the CAD-1 airship --- Canadian Airship Development A75-26002

The basic characteristics of hybrid aircraft A75-26005

The Dynairship --- deltoid aerobody combining buoyant and dynamic lift A75-26007

Some aspects of Hybrid-Zeppelins --- with slender delta wing A75-26008

Airship logistics - The LTA vehicle, a total cargo system A75-26015

Special problems and capabilities of high altitude lighter than air vehicles --- superpressure powered aerostat design A75-26021

A practical concept for powered or tethered weight-lifting LTA vehicles A75-26022

Technology update - Tethered aerostat structural design and material developments A75-26024

Two lighter than air systems in opposing flight regimes - An unmanned short haul, heavy load transport balloon and a manned, light payload airship A75-26025

Analysis and preliminary design of an advanced technology transport flight control system [NASA-CR-2490] N75-17295

The use of titanium and its alloys in the manufacture of helicopters and aircraft structures [BR44857] N75-17337

Preliminary ride-quality evaluation of the HH.2 Hoverferry [NASA-CR-142290] N75-17338

Future long-range transports: Prospects for improved fuel efficiency [NASA-TN-X-72659] N75-17339

FAA JT3D quiet nacelle retrofit feasibility program. Volume 4: Compatibility analysis and design study for DC-8 aircraft [AD-783187] N75-17357

Input design for identification of aircraft stability and control derivatives [NASA-CR-2493] N75-17370

Flight control systems properties and problems, volume 1 [NASA-CR-2500] N75-17371

Flight control systems properties and problems. Volume 2: Block diagram compendium [NASA-CR-2501] N75-17372

Aerodynamic design and analysis system for supersonic aircraft. Part 1: General description and theoretical development [NASA-CR-2520] N75-18185

Aerodynamic design and analysis system for supersonic aircraft. Part 3: Computer program description [NASA-CR-2522] N75-18186

Engine/airframe compatibility studies for supersonic cruise aircraft [NASA-CR-132610] N75-18221

AIRCRAFT DETECTION

Target identification by natural resonance estimation --- radar signatures A75-25878

Millimeter radar for low angle tracking A75-26038

AIRCRAFT ENGINES

Altitude evaluation of a variable cycle turbofan engine [SAE PAPER 740806] A75-22938

Matrix difference equation analysis of vibrating periodic structures --- aircraft engine parts A75-23201

Design of low-pollution burners A75-24945

Developmental programs for small expendable turbojets A75-24946

Impact response of graphite-epoxy flat laminates using projectiles that simulate aircraft engine encounters A75-25232

Engine failure prediction techniques A75-25274

The noise behaviour of aero engine turbine tones [AIAA PAPER 75-466] A75-25742

Engineering and development program plan: Aircraft propulsion systems air pollution [AD-777484] N75-17835

Preliminary study of advanced turbofans for low energy consumption [NASA-TN-X-71663] N75-18241

AIRCRAFT EQUIPMENT

Aircraft switching devices: Fabrication technology and installation --- Russian book A75-23369

Exploitation of air conditioning systems for passenger aircraft --- Russian book A75-23375

The Il-18 aircraft /2nd enlarged and revised edition/ --- Russian book A75-23421

VSCP starter generator --- variable speed constant frequency cycloconverter for aircraft applications A75-23594

Navy Aircrew Escape Propulsion System Program A75-25054

SUBJECT INDEX

AIRCRAFT NOISE

- Factors in the design of solid oxygen systems for aircraft
A75-25061
- Warranties as a life-cycle-cost management tool
--- for military aircraft equipment
A75-26099
- Catalytic reactor for inerting of aircraft fuel tanks
[AD-A000939]
N75-18228
- AIRCRAFT FUELS**
Fuelling systems --- at airports
A75-25275
- AIRCRAFT GUIDANCE**
Aids to air navigation
A75-23349
- Theory of astronomical correction --- Russian book on celestial navigation of flight vehicles
A75-23395
- Control, stabilization, and guidance of flight vehicles
[DGLR PAPER 74-75]
A75-24133
- Adaption processes in aircraft guidance systems
[AD-A000354]
N75-17329
- AIRCRAFT HAZARDS**
Foreign object impact damage to composites; Proceedings of the Symposium, Philadelphia, Pa., September 20, 1973
A75-25229
- Status of the wake vortex avoidance system --- in terminal airspace
A75-26060
- AIRCRAFT INDUSTRY**
Development trends in aircraft design --- economic analysis
[DGLR PAPER 74-68]
A75-24131
- AIRCRAFT INSTRUMENTS**
Predicting instrumental reliability of automated aircraft system monitoring based on critical parameter
A75-23810
- Evolution of the Douglas flight-test data system
A75-23888
- Digital avionics - An established technology
A75-24049
- Head-up and other displays
A75-24050
- Results of the investigation regarding two three-dimensional low-level flight control systems
[DGLR PAPER 74-83]
A75-24139
- Pilot control/display factors for helicopters
/PIFAX-H/
A75-25070
- US Army Human Engineering Laboratory helicopter cockpit lighting study. Phase 1: An evaluation of current and potential instrument panel lighting techniques for use in Army helicopters
[AD-A001527]
N75-17351
- AIRCRAFT LANDING**
Analysis of frequency error of airplane descent rate measured by a laser
A75-23797
- Aircraft noise in a high-rise city
A75-24000
- A flight research program to develop airborne systems for improved terminal area operations
A75-24803
- Status of the wake vortex avoidance system --- in terminal airspace
A75-26060
- The civil aircraft airworthiness data recording programme. A study of normal operational landing performance on subsonic civil jet aircraft
[ARC-CP-1273]
N75-17320
- An investigation of errors and data processing techniques for an RF multilateration system --- position and velocity measurements of vertical takeoff aircraft during landing
[NASA-CR-132609]
N75-17327
- Flight test investigation of the vortex wake characteristics behind a Boeing 727 during two-segment and normal ILS approaches (A joint NASA/PAA report)
[NASA-TM-X-62398]
N75-17340
- Landing impact studies of a 0.3-scale model air cushion landing system for a Navy fighter airplane
[NASA-TN-D-7875]
N75-17342
- Surface effect takeoff and landing system (SETOLS)
[AD-A000101]
N75-17345
- Helicopter TERPS validation study, phase 1
[AD-A000423]
N75-17347
- An investigation of rooftop STOL port aerodynamics
[NASA-CR-132570]
N75-17381
- Pilot preference and procedures at uncontrolled airports
[NASA-TN-D-7928]
N75-18169
- An experimental simulation study of four crosswind landing gear concepts
[NASA-TN-D-7864]
N75-18184
- The flight investigation and analysis of longitudinal handling qualities of STOL aircraft on landing approach
[AD-A001596]
N75-18254
- Development of a non-survey method estimating traffic at nontowered airports
[AD-A002397]
N75-18263
- AIRCRAFT MAINTENANCE**
Connection between the flight plan and the repair hangar control plan and its meaning for the quality of the transport process
A75-23043
- Maintenance overhauls performed according to an overhaul schedule --- programming aircraft repairs
A75-23044
- Methods of production planning in aircraft maintenance
A75-23045
- Observations on the construction and use of airplane hangars
A75-23046
- The defect recording system and defect statistics for aircraft technology used by the CSA
A75-23047
- Applications of electronic data processing in aircraft maintenance
A75-23048
- Methods of inspecting and preventing work defects during maintenance --- of aircraft
A75-23049
- Handbook for aircraft mechanics /3rd revised and enlarged edition/
A75-23366
- Reliability of airframes --- Russian book on quality control during planning, production and maintenance
A75-23428
- Simulation - An aid to aircraft maintenance management
A75-24756
- Breaking with tradition --- airlines economic efficiency
A75-25125
- AIRCRAFT MANEUVERS**
AFTI TI-1 program --- Advanced Fighter Technology Integration
[SAE PAPER 740860]
A75-22939
- AIRCRAFT MODELS**
Static computation of a wing model made of carbon fiber reinforced plastic /bending-torsion box/ with the aid of the method of finite elements and a comparison with experimental values
[DGLR PAPER 74-118]
A75-24155
- Airframe noise measurements on a transport model in a quiet flow facility
[AIAA PAPER 75-509]
A75-25775
- Wind tunnel investigations on an airplane model with variable sweepback in the incompressible region. Part 1: Comparison of the most important experimental parameters and their influence on the aerodynamic coefficients
[IPD-4/73-PT-1]
N75-17298
- AIRCRAFT NOISE**
The scattering of sound by a vortex sheet
A75-22934
- Airport noise abatement - How effective can it be
A75-23125
- Noise legislation and regulations
A75-23436
- Aircraft noise in a high-rise city
A75-24000
- The design of flight control devices with the aid of modern system theory
[DGLR PAPER 74-77]
A75-24134
- Methods for the determination of noise protection areas in accordance with the law for protection against aircraft noise
[DGLR PAPER 74-110]
A75-24150

AIRCRAFT PARTS

SUBJECT INDEX

A contribution to the problem of noise produced at the takeoff and landing of VTOL aircraft
[DGLR PAPER 74-116] A75-24153

Recent advances in the technology of aircraft noise control
[AIAA PAPER 75-317] A75-25014

Noncompact source effect on the prediction of tone noise from a fan rotor
[AIAA PAPER 75-446] A75-25730

Discrete frequency rotor noise --- from helicopters
[AIAA PAPER 75-451] A75-25733

V/STOL rotor and propeller noise - Its prediction and analysis of its aural characteristics
[AIAA PAPER 75-452] A75-25734

The development of experimental techniques for the study of helicopter rotor noise
[AIAA PAPER 75-455] A75-25736

Simulation of flight effects on aero engine fan noise
[AIAA PAPER 75-463] A75-25739

Fluctuating pressures on aircraft wing and flap surfaces associated with powered-lift systems
[AIAA PAPER 75-472] A75-25747

Noise shielding effects for engine-over-wing installations
[AIAA PAPER 75-474] A75-25749

Aircraft far-field aerodynamic noise - Its measurement and prediction
[AIAA PAPER 75-486] A75-25756

Trailing edge noise --- generated by oscillatory flow on flat plate
[AIAA PAPER 75-489] A75-25759

Airframe noise measurements on a transport model in a quiet flow facility
[AIAA PAPER 75-509] A75-25775

Measurements and analysis of aircraft airframe noise
[AIAA PAPER 75-510] A75-25776

An experimental study of airframe self-noise
[AIAA PAPER 75-511] A75-25777

A preliminary investigation of remotely piloted vehicles for airframe noise research
[AIAA PAPER 75-512] A75-25778

An experimental investigation of noise-shielding effects for a delta-winged aircraft in flight, wind tunnel and anechoic room
[AIAA PAPER 75-513] A75-25779

Core engine noise due to temperature fluctuations convecting through turbine blade rows
[AIAA PAPER 75-528] A75-25791

Development of a new computer system for aircraft noise prediction
[AIAA PAPER 75-536] A75-25798

Aircraft flyover noise measurements
[AIAA PAPER 75-537] A75-25799

Review of theory and methods for the prediction of ground effects on aircraft noise propagation
[AIAA PAPER 75-538] A75-25800

Methods for the prediction of airframe aerodynamic noise
[AIAA PAPER 75-539] A75-25801

Propagation of aircraft noise over long distances through the lower atmosphere
[AIAA PAPER 75-542] A75-25804

Atmospheric refraction of sonic boom from aircraft at low supersonic speeds
[AIAA PAPER 75-547] A75-25809

Noise reduction studies for the U-10 airplane
[NASA-TM-X-72640] N75-17360

Prediction of airframe noise
[NASA-TN-D-78211] N75-18182

Noise reduction studies for the Cessna model 337 (0-2) airplane
[NASA-TM-X-72641] N75-18231

Noise reduction studies for the OV-1 airplane
[NASA-TM-X-72639] N75-18232

Noise characteristics of the O-1 airplane and some approaches to noise reduction
[NASA-TM-X-72638] N75-18233

Ground noise measurements during static and flyby operations of the Cessna 02-T turbine powered airplane
[NASA-TM-X-72642] N75-18234

Noise reduction studies of several aircraft to reduce their aural detection distances
[NASA-TM-X-72644] N75-18235

A noise study of the A-6 airplane and techniques for reducing its aural detection distance
[NASA-TM-X-72643] N75-18236

AIRCRAFT PARTS

F-15 secondary power systems
[SAE PAPER 740885] A75-22948

Precision casting of aircraft and turbocompressor parts by the method of melted out models A75-24828

AIRCRAFT PERFORMANCE

Transonic wing design and its effects on flight performance
[DGLR PAPER 74-97] A75-24144

1974 report to the aerospace profession; Proceedings of the Eighteenth Symposium, Beverly Hills, Calif., September 25-28, 1974 A75-24802

Technology for improved safety --- for general aviation
[AIAA PAPER 75-291] A75-25008

Basic relationships for LTA technical analysis --- performance evaluation A75-25981

The effects of selected modern technological concepts on the performance and handling characteristics of LTA vehicles A75-25982

Floating vs flying - A propulsion energy comparison A75-25987

Preliminary ride-quality evaluation of the HM.2 Hoverferry
[NASA-CR-142290] N75-17338

A pilot's opinion of the P-8 digital fly-by-wire airplane N75-18252

The flight investigation and analysis of longitudinal handling qualities of STOL aircraft on landing approach
[AD-A001596] N75-18254

AIRCRAFT PRODUCTION

Cost-competitive B-1 composite secondary structures
[SME PAPER EM74-732] A75-23443

Trends in aerospace vehicle design
[SAWE PAPER SWR 4] A75-24346

The Slate all metal airship --- design and historical survey A75-25998

AIRCRAFT RELIABILITY

Methods of inspecting and preventing work defects during maintenance --- of aircraft A75-23049

Reliability of airframes --- Russian book on quality control during planning, production and maintenance A75-23428

The civil aircraft airworthiness data recording programme. A study of normal operational landing performance on subsonic civil jet aircraft
[ARC-CP-1273] N75-17320

AIRCRAFT SAFETY

Technology for improved safety --- for general aviation
[AIAA PAPER 75-291] A75-25008

General aviation safety - Fact and fiction A75-25719

Corporate/executive aircraft passenger safety - An educational approach A75-25874

AIRCRAFT STABILITY

On empennage stability --- aircraft control surface deflection A75-23802

Control, stabilization, and guidance of flight vehicles
[DGLR PAPER 74-75] A75-24133

Report on spin test of AJ37 Viggen A75-24807

The effect of ground proximity on the lateral/directional aerodynamic and control characteristics of a tilt-wing V/STOL aircraft at high lift coefficients
[AD-A001584] N75-18227

AIRCRAFT STRUCTURES

Static structural test for supersonic aircraft --- Russian book A75-23233

The Il-18 aircraft /2nd enlarged and revised edition/ --- Russian book A75-23421

Load distribution on threads of titanium tension nuts and steel bolts
[ASME PAPER 74-DE-N] A75-23638

SUBJECT INDEX

AIRPORT PLANNING

- Fracture mechanics' impact on specifications and supply --- test methods for aircraft aluminum alloys
A75-24004
- A curve fitting method for solving the flutter equation
[NASA-CR-132629] N75-17341
- Weapon system costing methodology for aircraft airframes and basic structures. Volume 3: Cost data base
[AD-A000399] N75-17348
- On the natural vibration of plate-beam combination structures, 4
[NAL-TR-363] N75-17707
- AIRCRAFT SURVIVABILITY**
Comparisons of the ballistic impact response of metals and composites for military aircraft applications
A75-25230
- AIRCRAFT WAKES**
Measurements of supersonic jet aircraft wakes in the stratosphere
A75-23962
- The structure and dynamics of vortex filaments --- in aircraft wakes
A75-24481
- Status of the wake vortex avoidance system --- in terminal airspace
A75-26060
- Wind tunnel investigation of the wake near the trailing edge of a distributed upper-surface-blown flap
[NASA-TN-X-72637] N75-18176
- Analytical study of ventilated wind tunnel boundary interference on V/STOL models including wake curvature and decay effects
[NASA-CR-142240] N75-18188
- The measurement of the McDonnell-Douglas DC-9 trailing vortex system using the tower fly-by technique
[AD-A001456/3] N75-18222
- AIRFOIL PROFILES**
Stress-strain state and springback in elastic-plastic torsion of profiles with open cross section contour
A75-23809
- The determination of the subsonic flow of a Chaplygin gas around a circular profile in the presence of circulation
A75-24061
- Transonic profile design --- gas dynamic analysis
[DGLR PAPER 74-98] A75-24145
- Contribution to the study of supercritical profile flow
[DGLR PAPER 74-99] A75-24146
- Transonic wind tunnel tests on two-dimensional aerofoil sections Part 1: Determination of pressure distribution and drag for an aerofoil of type NLR 13 in PFA wind tunnel S5
[PFA-TN-AU-725-PT-1] N75-17299
- Ice simulation: A 2-dimensional wind tunnel investigation of a NACA 652A215 wing section with single slotted flap. Part 2: Configurations typical for transport airplanes
[PFA-TN-AU-995-PT-2] N75-17309
- The viscous flow around a two dimensional high lift wing. Analysis of boundary layer measurements
[PFA-TN-AU-1155] N75-17310
- Transonic wind tunnel tests on two blunt trailing edge aerofoils
[ARL/A-NOTE-351] N75-18175
- Application of numerical optimization to the design of low speed airfoils
[NASA-TN-X-3213] N75-18181
- Airfoil optimization utilizing a remotely controlled flexible model. Phase 1: Low speed wind tunnel test
[AD-A001094] N75-18189
- AIRFOILS**
Measured three-dimensional effects in transonic airfoil testing
A75-23222
- Noncompact source effect on the prediction of tone noise from a fan rotor
[AIAA PAPER 75-446] A75-25730
- Comparison between dynamic stability boundaries for NPL 9615 and NACA 0012 aerofoils pitching about the quarter-chord
[ARC-CP-1279] N75-17302
- A limiting case of multiphase flow past slender bodies
[AD-A000240] N75-17313
- Studies of separated flows --- interaction of turbulent boundary layers with inviscid flow around transonic airfoils
[AD-A000348] N75-17626
- Structural response of a fiber composite compressor fan blade airfoil
[NASA-TN-X-71623] N75-17709
- AIRFRAME MATERIALS**
Combining strength and fracture toughness --- vacuum arc melted steels for aerospace applications
A75-24002
- Development and use of types of construction employing fiber-reinforced materials --- German book on aircraft materials
[DGLR PAPER 14-117] A75-24154
- Comparisons of the ballistic impact response of metals and composites for military aircraft applications
A75-25230
- AIRFRAMES**
Reliability of airframes --- Russian book on quality control during planning, production and maintenance
A75-23428
- Diagnostic calculations of airframe-radiated noise
[AIAA PAPER 75-485] A75-25755
- Induced drag effect on airframe noise
[AIAA PAPER 75-487] A75-25757
- Airframe noise measurements on a transport model in a quiet flow facility
[AIAA PAPER 75-509] A75-25775
- Measurements and analysis of aircraft airframe noise
[AIAA PAPER 75-510] A75-25776
- An experimental study of airframe self-noise
[AIAA PAPER 75-511] A75-25777
- A preliminary investigation of remotely piloted vehicles for airframe noise research
[AIAA PAPER 75-512] A75-25778
- Methods for the prediction of airframe aerodynamic noise
[AIAA PAPER 75-539] A75-25801
- The use of titanium and its alloys in the manufacture of helicopters and aircraft structures
[BR44857] N75-17337
- Weapon system costing methodology for aircraft airframes and basic structures. Volume 3: Cost data base
[AD-A000399] N75-17348
- AIRLINE OPERATIONS**
Connection between the flight plan and the repair hangar control plan and its meaning for the quality of the transport process
A75-23043
- Applications of electronic data processing in aircraft maintenance
A75-23048
- Breaking with tradition --- airlines economic efficiency
A75-25125
- Process of selection and quantization in the case of the fleet of Iberia
A75-25863
- An overview of the upgraded third generation air traffic control system
A75-26059
- Evaluation of routing and scheduling considerations for possible future commercial hypersonic transport aircraft
[NASA-CR-132632] N75-18193
- AIRPLANE PRODUCTION COSTS**
S-3A Design-to-a-Cost program
[SME PAPER 8874-710] A75-23439
- Cost-competitive B-1 composite secondary structures
[SME PAPER 8874-732] A75-23443
- AIRPORT PLANNING**
Methods for the determination of noise protection areas in accordance with the law for protection against aircraft noise
[DGLR PAPER 74-110] A75-24150
- RTOL and steep approach - Why
[DGLR PAPER 74-112] A75-24152

AIRPORTS

Decision-making model for ATC system improvement
A75-24754
Fire-fighting in airport premises
A75-25342
Mobile lounge or fixed gate --- airport terminal
design
A75-25343

AIRPORTS

Airport noise abatement - How effective can it be
A75-23125
Aircraft noise in a high-rise city
A75-24000
A contribution to the problem of noise produced at
the takeoff and landing of VTOL aircraft
[DCLR PAPER 74-116]
A75-24153
Advanced signal processing for airport
surveillance radars
A75-26037
Ground-based collision avoidance systems for air
traffic
A75-26062
Development of a non-survey method estimating
traffic at nontowered airports
[AD-A002397]
A75-18263

AIRSHIPS

A solution to the transport of exceptionally large
loads - The dirigible
A75-23199
Interagency Workshop on Lighter than Air Vehicles,
Monterey, Calif., September 9-13, 1974,
Proceedings
A75-25969
Where do we go from here --- in airship technology
A75-25970
Basic relationships for LTA economic analysis
A75-25971
Preliminary estimates of operating costs for
lighter than air transports
A75-25972
Comparative airship economics --- design and
freight transport factors
A75-25973
Effect of present technology on airship capabilities
A75-25974
An economic comparison of three heavy lift
airborne systems
A75-25978
An approach to market analysis for lighter than
air transportation of freight
A75-25979
Market assessment in connection with lighter than
air --- airships
A75-25980
Basic relationships for LTA technical analysis ---
performance evaluation
A75-25981
The effects of selected modern technological
concepts on the performance and handling
characteristics of LTA vehicles
A75-25982
Boundary layer control for airships
A75-25983
Airship stresses due to vertical velocity
gradients and atmospheric turbulence
A75-25984
An aerodynamic load criterion for airships
A75-25985
The planar dynamics of airships
A75-25986
Floating vs flying - A propulsion energy comparison
A75-25987
Long fluid filled bags suspended by line forces
--- for airship design
A75-25988
LTA structures and materials technology --- airships
A75-25991
Potential contribution of high strength, high
modulus aramid fibers to the commercial
feasibility of lighter than air craft
A75-25992
Operational considerations for the airship in
short-haul transportation
A75-25993
Design aspects of zeppelin operations from case
histories
A75-25994
Lighter than air - A look at the past, a look at
the possibilities
A75-25995

SUBJECT INDEX

Mooring and ground handling rigid airships
A75-25996
A new concept for airship mooring and ground
handling
A75-25997
The Slate all metal airship --- design and
historical survey
A75-25998
State of the art of metalclad airships
A75-25999
The aerospace developments concept --- airship
design for natural gas transport
A75-26000
The design and construction of the CAD-1 airship
--- Canadian Airship Development
A75-26002
An LTA flight research vehicle --- airship
development
A75-26003
The Airfloat HL project --- heavy lift airship
A75-26004
The basic characteristics of hybrid aircraft
A75-26005
A semibuoyant vehicle for general transportation
missions
A75-26006
The Dynairship --- deltoid aerobody combining
buoyant and dynamic lift
A75-26007
Some aspects of Hybrid-Zeppelins --- with slender
delta wing
A75-26008
Ultra-heavy vertical lift system 'The Heli-Stat'
--- combined LTA-helicopter design
A75-26009
The variable density aircraft concept
A75-26010
The application of the airship to regions lacking
in transport infrastructure
A75-26012
Military applications of rigid airships --- aerial
surveillance and cargo transport
A75-26013
Potential ASW missions for lighter than air ships
A75-26014
Airship logistics - The LTA vehicle, a total cargo
system
A75-26015
Airships for transporting highly volatile
commodities --- compared with ocean tankers and
gas pipelines
A75-26017
Using lighter than air vehicles /dirigibles/ in
housing construction
A75-26018
Aerocrane - A hybrid LTA aircraft for aerial crane
applications
A75-26019
Special problems and capabilities of high altitude
lighter than air vehicles --- superpressure
powered aerostat design
A75-26021
A practical concept for powered or tethered
weight-lifting LTA vehicles
A75-26022
A revolutionary and operational tethered aerostat
system illustrating new LTA technology
A75-26023
Technology update - Tethered aerostat structural
design and material developments
A75-26024
Two lighter than air systems in opposing flight
regimes - An unmanned short haul, heavy load
transport balloon and a manned, light payload
airship
A75-26025
'LOTS' of LTA applications --- Logistics Over The
Shore operations
A75-26027
Remotely piloted LTA vehicle for surveillance
A75-26028
AIRSPEED
Forward velocity effects on under-the-wing
externally blown flap noise
[AIAA PAPER 75-476]
A75-25750
The effects of forward speed on a number of
turbojet exhaust silencers
[AIAA PAPER 75-506]
A75-25772

- Surveillance velocity measurements with least maximum error
A75-25928
- ALPHA JET AIRCRAFT**
The Alpha-Jet spoiler of carbon-epoxy material
[DGLR PAPER 74-119] A75-24156
- ALTITUDE TESTS**
Altitude evaluation of a variable cycle turbofan engine
[SAE PAPER 740806] A75-22938
- ALUMINUM ALLOYS**
Cost savings in the application of P/M titanium and P/M aluminum alloys
A75-23412
Fracture mechanics' impact on specifications and supply --- test methods for aircraft aluminum alloys
A75-24004
- ALUMINUM COATINGS**
Coatings protect superalloys in gas-turbine applications
A75-24005
- ANALOG SIMULATION**
Aircraft flutter simulation by means of the electronic analogue computer with special regard to structural nonlinearities
[ESRO-TT-121] N75-17384
- ANGULAR MOMENTUM**
The steady state and dynamic behaviour of the turbo-bearing
A75-23615
- ANNULAR FLOW**
'Ring vortex' energy losses during centrifugal fan operation in low output regimes
A75-23806
Flow determination at the exit of a moving supersonic annular blade cascade
[ONERA, TP NO. 1370] A75-23946
- ANNULAR NOZZLES**
Study of annular nozzle cascades with different 'reverse' vane twist
A75-23818
- ANTENNA DESIGN**
Laterally displaced ISLS antenna for tactical radar --- Interrogation Side Lobe Suppression
A75-25926
- ANTENNA FEEDS**
ASR-5 radar dual feedhorn antenna modification. Volume 1: Description of hardware and summary of feasibility effort
[AD-781348] N75-17573
- ANTIOXIDANTS**
Laboratory evaluation of the stability of high-purity jet fuels of the T-8 type and of the effectiveness of antioxidants
A75-24274
- ANTISUBMARINE WARFARE**
Potential ASW missions for lighter than air ships
A75-26014
- APPROACH CONTROL**
Pilot preference and procedures at uncontrolled airports
[NASA-TN-D-7928] N75-18169
- APPROACH INDICATORS**
An investigation of errors and data processing techniques for an RF multilateration system --- position and velocity measurements of vertical takeoff aircraft during landing
[NASA-CR-132609] N75-17327
- ARC MELTING**
Combining strength and fracture toughness --- vacuum arc melted steels for aerospace applications
A75-24002
- ASTRONOMICAL COORDINATES**
Theory of astronomical correction --- Russian book on celestial navigation of flight vehicles
A75-23395
- ATMOSPHERIC ATTENUATION**
Propagation of aircraft noise over long distances through the lower atmosphere
[AIAA PAPER 75-542] A75-25804
On the excess attenuation of sound in the atmosphere
[NASA-TN-D-7823] N75-18030
- ATMOSPHERIC CIRCULATION**
First results of a general circulation model applied to the SST-NOx problem --- ozone decomposition
A75-23982
- ATMOSPHERIC ELECTRICITY**
Electrostatic vertical sensing and control concept for aircraft escape systems
A75-25068
The effects of lightning on digital flight control systems
N75-18249
- ATMOSPHERIC MODELS**
Possible climatic effects of supersonic transports
A75-23973
First results of a general circulation model applied to the SST-NOx problem --- ozone decomposition
A75-23982
- ATMOSPHERIC REFRACTION**
Atmospheric refraction of sonic boom from aircraft at low supersonic speeds
[AIAA PAPER 75-547] A75-25809
- ATMOSPHERIC TURBULENCE**
Airship stresses due to vertical velocity gradients and atmospheric turbulence
A75-25984
- ATTITUDE CONTROL**
Electrostatic vertical sensing and control concept for aircraft escape systems
A75-25068
- ATTITUDE STABILITY**
SLAB, its principles of operation and requirements regarding the positional stability of carrier platforms
A75-25697
- AUTOMATIC CONTROL**
Automatic balancing of rotors in high-speed machines --- Russian book on turbomachines
A75-23397
Predicting instrumental reliability of automated aircraft system monitoring based on critical parameter
A75-23810
The use of digital computers in air traffic control
A75-25862
Advanced signal processing for airport surveillance radars
A75-26037
- AUTOMATIC FLIGHT CONTROL**
The design of flight control devices with the aid of modern system theory
[DGLR PAPER 74-77] A75-24134
A controller of variable structure for the reduction of the complexity of flight control systems
[DGLR PAPER 74-79] A75-24136
Control and program technology for the implementation of digital flight control systems
[DGLR PAPER 74-81] A75-24138
Flight control systems properties and problems. Volume 2: Block diagram compendium
[NASA-CR-2501] N75-17372
Three-axis fluidic/electronic automatic flight control system flight test report
[AD-A000894] N75-17379
- AUTOMATIC PILOTS**
Control and program technology for the implementation of digital flight control systems
[DGLR PAPER 74-81] A75-24138
Electrostatic vertical sensing and control concept for aircraft escape systems
A75-25068
Adaption processes in aircraft guidance systems
[AD-A000354] N75-17329
- AUTOMATIC TEST EQUIPMENT**
Automatic Test System Jet Engine Accessories
A75-23649
The future of real time telemetry systems --- for computerized testing of aerospace vehicles
A75-23889
- AUXILIARY POWER SOURCES**
F-15 secondary power systems
[SAE PAPER 740885] A75-22948
- AVIONICS**
Digital avionics - An established technology
A75-24049
Head-up and other displays
A75-24050
AEROSAT test and evaluation avionics --- aeronautical satellite communication system for oceanic ATC
A75-26043

- Analysis and preliminary design of an advanced technology transport flight control system
[NASA-CR-2490] N75-17295
- AXIAL FLOW TURBINES**
Pressure increase in blade channels of axial-flow compressors at low gas pressures A75-23099
- Study of annular nozzle cascades with different 'reverse' vane twist A75-23818
- Flow determination at the exit of a moving supersonic annular blade cascade
[ONERA, TP NO. 1370] A75-23946
- AXIAL LOADS**
A new biaxial tensile testing machine A75-24068

B

- B-1 AIRCRAFT**
Cost-competitive B-1 composite secondary structures
[SME PAPER EM74-732] A75-23443
Proposed windshield for B-1 aircraft: An optical evaluation
[AD-A001078] N75-17350
- BALANCING**
Automatic balancing of rotors in high-speed machines
--- Russian book on turbomachines A75-23397
- BALLISTIC MISSILE SUBMARINES**
Potential ASW missions for lighter than air ships A75-26014
- BALLOON FLIGHT**
Unmanned powered balloons A75-26020
- BALLOONS**
Two lighter than air systems in opposing flight regimes - An unmanned short haul, heavy load transport balloon and a manned, light payload airship A75-26025
Balloon logging with the inverted skyline --- timber transport system A75-26026
- BEAMS (SUPPORTS)**
On the natural vibration of plate-beam combination structures, 4
[NAL-TR-363] N75-17707
- BEECHCRAFT AIRCRAFT**
Evaluation of the effect of a yaw-rate damper on the lateral-directional stability and control of the Beechcraft Queen Air 80 laboratory aircraft
[NLR-TR-73105-U] N75-17374
- BENDING MOMENTS**
On empennage stability --- aircraft control surface deflection A75-23802
An aerodynamic load criterion for airships A75-25985
- BIT SYNCHRONIZATION**
Flexibility objectives for real-time telemetry processing systems --- four block model A75-23887
- BLOWING**
Acoustic characteristics of a large upper-surface blown configuration with turbofan engines
[AIAA PAPER 75-473] A75-25748
- BLUNT BODIES**
Entropy layer on a supersonic plane flat nose at incidence A75-23208
Aerodynamic heating of supersonic blunt bodies
[AD-A001135] N75-18190
- BODY-WING AND TAIL CONFIGURATIONS**
Some aspects of Hybrid-Zeppelins --- with slender delta wing A75-26008
- BODY-WING CONFIGURATIONS**
Noise shielding effects for engine-over-wing installations
[AIAA PAPER 75-474] A75-25749
Application of the equivalent mechanical flap concept to jet flapped wing-body combinations
[AD-A000431] N75-17346
Aerodynamic testing technique for twin fuselage models at hypersonic speeds
[NASA-TN-X-3196] N75-18187

- BOEING 707 AIRCRAFT**
FAA JT3D quiet nacelle retrofit feasibility program. Volume 3: Lower goal flight testing, economic analyses and summary
[AD-787610] N75-17334
Gust loads on 707 and VC 10 aircraft
[ARC-CP-1281] N75-17373
- BOEING 727 AIRCRAFT**
Flight test investigation of the vortex wake characteristics behind a Boeing 727 during two-segment and normal ILS approaches (A joint NASA/FAA report)
[NASA-TN-X-62398] N75-17340
- BOEING 747 AIRCRAFT**
Emergency and disaster plans, and associated problems concerning major aircraft accidents A75-25069
- BOLTS**
Load distribution on threads of titanium tension nuts and steel bolts
[ASME PAPER 74-DE-N] A75-23638
- BORON**
Measurement of advanced composition materials shielding effectiveness
[AD-A000414] N75-17425
- BORON REINFORCED MATERIALS**
Development of a VFW-614 spoiler in a design utilizing boron fiber reinforced plastic
[DGLR PAPER 74-121] A75-24158
- BOUNDARY LAYER CONTROL**
Recent progress in experimental studies of afterbodies A75-24943
Boundary layer control for airships A75-25983
State of the art of metalclad airships A75-25999
- BOUNDARY LAYER FLOW**
Calculation of turbulent shear stress in supersonic boundary-layer flows A75-23209
- BOUNDARY LAYER SEPARATION**
Separation of turbulent boundary layer on a lifting cylinder A75-23223
- BOUNDARY VALUE PROBLEMS**
The effect of initial values on wing form and the limiting curve of the wave drag coefficients of optimized symmetrical-thick delta wings in supersonic flow A75-23100
- BOW WAVES**
The scattering of sound by a vortex sheet A75-22934
- BUCKLING**
Stability theory and its applications to structural mechanics --- Book A75-25181
- BUILDINGS**
An investigation of rooftop STOL port aerodynamics
[NASA-CR-132570] N75-17381
- BUOYANCY**
The planar dynamics of airships A75-25986
The Dynairship --- deltoid aerobody combining buoyant and dynamic lift A75-26007
The variable density aircraft concept A75-26010

C

- CABIN ATMOSPHERES**
Exploitation of air conditioning systems for passenger aircraft --- Russian book A75-23375
- CANARD CONFIGURATIONS**
Fly-by-wire delta-canard configurations save weight
[SAE PAPER SVR 3] A75-24345
- CARBON FIBER REINFORCED PLASTICS**
Advanced composite design concepts for the AMST
[SAE PAPER 740870] A75-22944
Static computation of a wing model made of carbon fiber reinforced plastic /bending-torsion box/ with the aid of the method of finite elements and a comparison with experimental values
[DGLR PAPER 74-118] A75-24155
The Alpha-Jet spoiler of carbon-epoxy material
[DGLR PAPER 74-119] A75-24156

- Impact response of graphite-epoxy flat laminates using projectiles that simulate aircraft engine encounters
A75-25232
- CARGO**
The application of the airship to regions lacking in transport infrastructure
A75-26012
- CARGO AIRCRAFT**
Comparative airship economics --- design and freight transport factors
A75-25973
Ultra-heavy vertical lift system 'The Heli-Stat' --- combined LTA-helicopter design
A75-26009
Airship logistics - The LTA vehicle, a total cargo system
A75-26015
Two lighter than air systems in opposing flight regimes - An unmanned short haul, heavy load transport balloon and a manned, light payload airship
A75-26025
- CASCADE FLOW**
Calculation of flutter boundary of dynamically nonuniform profile cascades
A75-23819
Flow determination at the exit of a moving supersonic annular blade cascade [ONERA, TP NO. 1370]
A75-23946
Experimental study of the unsteady flow through a turbomachine stage
A75-23947
Calculation by the singularity method of the characteristics of a cascade in compressible flow without knocking up to the supercritical speed
A75-23988
Wake cutting by a cascade of cambered blades [AIAA PAPER 75-445]
A75-25729
- CASTING**
Precision casting of aircraft and turbocompressor parts by the method of melted out models
A75-24828
- CATALYSTS**
Catalytic reactor for inerting of aircraft fuel tanks
[AD-A000939]
A75-18228
- CEILINGS (METEOROLOGY)**
Evaluation of a Sperry Lidar Ceilometer [AD-777820]
A75-17653
- CERESTIAL NAVIGATION**
Theory of astronomical correction --- Russian book on celestial navigation of flight vehicles
A75-23395
- CENTRIFUGAL COMPRESSORS**
'Ring vortex' energy losses during centrifugal fan operation in low output regimes
A75-23806
- CERAMIC COATINGS**
Coatings protect superalloys in gas-turbine applications
A75-24005
- CESSNA AIRCRAFT**
Noise reduction studies for the Cessna model 337 (O-2) airplane [NASA-TN-X-72641]
A75-18231
Ground noise measurements during static and flyby operations of the Cessna O2-T turbine powered airplane [NASA-TN-X-72642]
A75-18234
- CESSNA L-19 AIRCRAFT**
Noise characteristics of the O-1 airplane and some approaches to noise reduction [NASA-TN-X-72638]
A75-18233
- CHANNEL FLOW**
Pressure increase in blade channels of axial-flow compressors at low gas pressures
A75-23099
- CHAPLYGIN EQUATION**
The determination of the subsonic flow of a Chaplygin gas around a circular profile in the presence of circulation
A75-24061
- CHEMICAL EQUILIBRIUM**
Laboratory evaluation of the stability of high-purity jet fuels of the T-8 type and of the effectiveness of antioxidants
A75-24274
- CIRCUIT PROTECTION**
A procedure for the design of multifunction switching controls [AD-A000532]
A75-17354
- CIRCULAR CONES**
The diffraction of a shock wave by a slender body
A75-25458
- CIRCULAR CYLINDERS**
Experimental determination of the separation point of flow around a circular cylinder
A75-22868
Separation of turbulent boundary layer on a lifting cylinder
A75-23223
- CIRCULAR TUBES**
A leak-free mechanical tube joint
A75-23240
Effects of a conical segment on sound radiation from a circular duct [AIAA PAPER 75-517]
A75-25783
- CIVIL AVIATION**
The institutionalization and the general problems of air traffic
A75-23348
General aviation safety - Fact and fiction
A75-25719
An overview of the upgraded third generation air traffic control system
A75-26059
Aircraft accident reports. Brief format supplemental issue, 1973 accidents. File numbers 1-0040 thru 1-0042, 3-4141 thru 3-4163, 4-0001 thru 4-0032, 5-0001 thru 5-0035, 6-0001 thru 6-0086, A-0001 thru A-0003, A-0005, C-0001, E-0001 thru E-0023 [PB-237091/4]
A75-17322
- CLIMATOLOGY**
Possible climatic effects of supersonic transports
A75-23973
- CLOUD HEIGHT INDICATORS**
Evaluation of a Sperry Lidar Ceilometer [AD-777820]
A75-17653
- CLUTTER**
Advanced signal processing for airport surveillance radars
A75-26037
- COCKPITS**
US Army Human Engineering Laboratory helicopter cockpit lighting study. Phase 1: An evaluation of current and potential instrument panel lighting techniques for use in Army helicopters [AD-A001527]
A75-17351
A procedure for the design of multifunction switching controls [AD-A000532]
A75-17354
- COLLISION AVOIDANCE**
Results of the investigation regarding two three-dimensional low-level flight control systems [DGLR PAPER 74-83]
A75-24139
Ground-based collision avoidance systems for air traffic
A75-26062
Study of alternative beacon based surveillance and data link systems, volume 2 [AD-772136]
A75-17325
- COMBUSTION CHAMBERS**
Design of low-pollution burners
A75-24945
Idle efficiency and pollution results for two-row swirl-can combustors having 72 modules [NASA-TN-X-3208]
A75-18240
- COMBUSTION EFFICIENCY**
Idle efficiency and pollution results for two-row swirl-can combustors having 72 modules [NASA-TN-X-3208]
A75-18240
- COMBUSTION PRODUCTS**
Emission calibration of a J-58 afterburning turbojet engine at simulated supersonic, stratospheric flight conditions
A75-23964
Design of low-pollution burners
A75-24945
Prevaporization and premixing to obtain low oxides of nitrogen in gas turbine combustors [NASA-CR-2495]
A75-17362
Technology for reducing aircraft engine pollution [NASA-TN-X-71670]
A75-18237

COMBUSTION STABILITY

Combustion intensity and distribution relation to noise generation
[AIAA PAPER 75-524] A75-25788

COMMERCIAL AIRCRAFT

Advanced subsonic transports - A challenge for the 1990's
[AIAA PAPER 75-304] A75-23251
The shape of the future long-haul transport airplane
[AIAA PAPER 75-305] A75-25012

COMMUNICATION SATELLITES

Aero-marine communications by satellite A75-24100

COMPLEX SYSTEMS

The devising of control systems with the help of computer-aided design and their application
[DGLR PAPER 74-78] A75-24135
Multilevel control optimization using subsystem relative performance index sensitivity A75-25098

COMPONENT RELIABILITY

Predicting instrumental reliability of automated aircraft system monitoring based on critical parameter A75-23810

COMPOSITE MATERIALS

M/C tape laying - Tomorrow's future today --- for helicopter rotor blade manufacturing
[SME PAPER MS74-729] A75-23441
Evaluation of stiffness coefficients for fiber-reinforced laminated composites A75-23667

Development and use of types of construction employing fiber-reinforced materials --- German book on aircraft materials
[DGLR PAPER 74-117] A75-24154

Development of the inlet ramp of a supersonic aircraft, employing a design which utilizes a fiber composite material
[DGLR PAPER 74-120] A75-24157

Influence of velocity, impingement angle, heating, and aerodynamic shock layers on erosion of materials at velocities of 5500 ft per s /1700 m per s/ A75-25188

Foreign object impact damage to composites; Proceedings of the Symposium, Philadelphia, Pa., September 20, 1973 A75-25229

Measurement of advanced composition materials shielding effectiveness
[AD-A000414] N75-17425

Structural response of a fiber composite compressor fan blade airfoil
[NASA-TN-X-71623] N75-17709

COMPOSITE STRUCTURES

Cost-competitive B-1 composite secondary structures
[SME PAPER EM74-732] A75-23443
Comparisons of the ballistic impact response of metals and composites for military aircraft applications A75-25230

COMPRESSIBILITY EFFECTS

An analysis method for two-dimensional transonic viscous flow
[NASA-TN-D-7718] N75-18179

COMPRESSIBLE FLOW

Calculation by the singularity method of the characteristics of a cascade in compressible flow without knocking up to the supercritical speed A75-23988

COMPRESSOR BLADES

The use of fiber-reinforced materials for compressor blades
[DGLR PAPER 74-122] A75-24159

Structural response of a fiber composite compressor fan blade airfoil
[NASA-TN-X-71623] N75-17709

COMPRESSOR EFFICIENCY

Analytic specification of compressor characteristics A75-23816

COMPUTER PROGRAMS

The future of real time telemetry systems --- for computerized testing of aerospace vehicles A75-23889

Control and program technology for the implementation of digital flight control systems
[DGLR PAPER 74-81] A75-24138

Experimentally verified analytical techniques for predicting vehicle crash response
[AIAA PAPER 75-273] A75-25006
An iterative improvement for finite element analysis A75-25212

Methods for predicting the aerodynamic and stability and control characteristics of STOL aircraft. Volume 2: STOL aerodynamic methods computer program
[AD-A001581] N75-17376

Aerodynamic design and analysis system for supersonic aircraft. Part 3: Computer program description
[NASA-CR-2522] N75-18186

System design of a rudder coordination system --- optimization computer program
[NASA-CR-142245] N75-18223

Near field noise prediction for a linear array of turbojet engines
[AD-A001329] N75-18976

COMPUTER SYSTEMS DESIGN

Flexibility objectives for real-time telemetry processing systems --- four block model A75-23887

An integrated PCM data system for full scale aeronautics testing --- common data bases for user requirements A75-23902

COMPUTER TECHNIQUES

Compressor and turbine characteristic representation in algorithm for calculating turbojet engine throttling characteristics A75-23822

The use of digital computers in air traffic control A75-25862

COMPUTERIZED DESIGN

Analytic specification of compressor characteristics A75-23816

The devising of control systems with the help of computer-aided design and their application
[DGLR PAPER 74-78] A75-24135

Computer aided flexible envelope designs A75-25989

The design and construction of the CAD-1 airship --- Canadian Airship Development A75-26002

Application of numerical optimization to the design of low speed airfoils
[NASA-TN-X-3213] N75-18181

Aerodynamic design and analysis system for supersonic aircraft. Part 1: General description and theoretical development
[NASA-CR-2520] N75-18185

Aerodynamic design and analysis system for supersonic aircraft. Part 3: Computer program description
[NASA-CR-2522] N75-18186

COMPUTERIZED SIMULATION

Simulation - An aid to aircraft maintenance management A75-24756

Development of a new computer system for aircraft noise prediction
[AIAA PAPER 75-536] A75-25798

CONCORDE AIRCRAFT

Concorde inlet system and peripheral envelope flight testing A75-24804

CONFERENCES

1974 report to the aerospace profession; Proceedings of the Eighteenth Symposium, Beverly Hills, Calif., September 25-28, 1974 A75-24802

Survival and Flight Equipment Association, Annual Conference and Trade Exhibit, 12th, Las Vegas, Nev., September 8-12, 1974, Proceedings A75-25051

Foreign object impact damage to composites; Proceedings of the Symposium, Philadelphia, Pa., September 20, 1973 A75-25229

CONFORMAL MAPPING

Analytic construction of function for conformal transformation of exterior of circle onto exterior of arbitrary wing profile A75-23794

- CONICAL BODIES**
Effects of a conical segment on sound radiation from a circular duct
[AIAA PAPER 75-517] A75-25783
A prediction method for pressure distributions on compression surfaces of conical bodies at supersonic speeds --- delta wings, conical bodies, and two dimensional flow
[ARC-CP-1295] N75-17307
- CONICAL CAMBER**
Low-speed wind-tunnel tests on the lift-dependent drag of delta wings with conical camber
[ARC-CP-1293] N75-17306
- CONICAL NOZZLES**
Low Reynolds number hypersonic nozzle flows
A75-24270
- CONSERVATION EQUATIONS**
Generalized aerodynamic noise equation
A75-24418
- CONSTRUCTION**
Observations on the construction and use of airplane hangars
A75-23046
Using lighter than air vehicles /dirigibles/ in housing construction
A75-26018
- CONSTRUCTION MATERIALS**
Development and use of types of construction employing fiber-reinforced materials --- German book on aircraft materials
[DGLR PAPER 14-117] A75-24154
The Alpha-Jet spoiler of carbon-epoxy material
[DGLR PAPER 74-119] A75-24156
Development of a VFW-614 spoiler in a design utilizing boron fiber reinforced plastic
[DGLR PAPER 74-121] A75-24158
LTA structures and materials technology --- airships
A75-25991
Technology update - Tethered aerostat structural design and material developments
A75-26024
- CONTAMINANTS**
Idle efficiency and pollution results for two-row swirl-can combustors having 72 modules
[NASA-TN-X-3208] N75-18240
- CONTROL CONFIGURED VEHICLES**
P-4/CCV-flight tests of advanced technology
[SAE PAPER 740861] A75-22940
- CONTROL SIMULATION**
VTOL flight-control system design using sensitivity analysis
A75-25879
- CONTROL STABILITY**
Fluidic ejection seat control system
A75-25052
Flutter suppression and gust alleviation using active controls
[NASA-CR-142195] N75-18243
- CONTROL SURFACES**
Aircraft control surface actuators --- Russian book
A75-23423
A finite element approach to the aeroelastic analysis of lifting surface type structures
A75-24918
- CONTROL THEORY**
The devising of control systems with the help of computer-aided design and their application
[DGLR PAPER 74-78] A75-24135
- CONTROLLERS**
A controller of variable structure for the reduction of the complexity of flight control systems
[DGLR PAPER 74-79] A75-24136
- COOLING SYSTEMS**
Study of active cooling for supersonic transports
[NASA-CR-132573] N75-17336
- CORNER FLOW**
Numerical solutions for supersonic corner flow
A75-23295
- CORROSION PREVENTION**
Study of materials and nonmetallic coatings for erosion and wear resistance
A75-23942
Coatings protect superalloys in gas-turbine applications
A75-24005
- CORROSION RESISTANCE**
Hot corrosion in gas turbines
A75-24380
- COST ANALYSIS**
S-3A Design-to-a-Cost program
[SME PAPER MH74-710] A75-23439
Simulation - An aid to aircraft maintenance management
A75-24756
Comparative airship economics --- design and freight transport factors
A75-25973
Effect of present technology on airship capabilities
A75-25974
Method for transporting impellent gases
A75-26001
Balloon logging with the inverted skyline --- timber transport system
A75-26026
Warranties as a life-cycle-cost management tool --- for military aircraft equipment
A75-26099
- COST EFFECTIVENESS**
Airport noise abatement - How effective can it be
A75-23125
Cost savings in the application of P/M titanium and P/M aluminum alloys
A75-23412
Decision-making model for ATC system improvement
A75-24754
Breaking with tradition --- airlines economic efficiency
A75-25125
Lighter than air - A look at the past, a look at the possibilities
A75-25995
The Airfloat HL project --- heavy lift airship
A75-26004
- COST ESTIMATES**
Advanced composite design concepts for the AMST
[SAE PAPER 740870] A75-22944
Preliminary estimates of operating costs for lighter than air transports
A75-25972
Weapon system costing methodology for aircraft airframes and basic structures. Volume 3: Cost data base
[AD-A000399] N75-17348
- COST REDUCTION**
Observations on the construction and use of airplane hangars
A75-23046
Trends in aerospace vehicle design
[SAE PAPER SWR 4] A75-24346
State of the art of metalclad airships
A75-25999
- CRACK PROPAGATION**
Practical applications of acoustic emission --- for pressure vessels, aircraft structures and solid propellants
A75-24461
- CRASH INJURIES**
A crashworthy armored helicopter crew seat
A75-25055
- CRASH LANDING**
Experimentally verified analytical techniques for predicting vehicle crash response
[AIAA PAPER 75-273] A75-25006
- CRITICAL FLOW**
Calculation by the singularity method of the characteristics of a cascade in compressible flow without knocking up to the supercritical speed
A75-23988
- CROSS CORRELATION**
New evidence of subsonic jet noise mechanisms
[AIAA PAPER 75-437] A75-25724
Jet noise source location by cross-correlation of far field microphone signals
[AIAA PAPER 75-456] A75-25737
Cross-correlation of noise produced inside a hot turbojet exhaust with and without suppression using a new, hot probe
[AIAA PAPER 75-505] A75-25771
- CROSS FLOW**
A model for the vortex pair associated with a jet in a cross flow
[NASA-CR-136756] N75-17611
- CRYOGENIC EQUIPMENT**
A leak-free mechanical tube joint
A75-23240

CRYOGENIC FLUIDS

CRYOGENIC FLUIDS

- Ultrasonic flowmeter cell designs for liquids
A75-25951
- CURVE FITTING**
A curve fitting method for solving the flutter equation
[NASA-CR-132629] A75-17341
- CUSHIONS**
Experimental study of a two pressure stage air cushion
[NT-36] A75-18174

D

DAMPING

- Evaluation of the effect of a yaw-rate damper on the lateral-directional stability and control of the Beechcraft Queen Air 80 laboratory aircraft
[NLR-TR-73105-U] A75-17374

DATA LINKS

- DABS - Projected performance and experimental results --- Discrete Address Beacon System for ATC
A75-26061

DATA PROCESSING

- Applications of electronic data processing in aircraft maintenance
A75-23048
- Effects of time-shifted data on flight determined stability and control derivatives
[NASA-TN-D-7830] A75-18244

DATA PROCESSING EQUIPMENT

- Flexibility objectives for real-time telemetry processing systems --- four block model
A75-23887

DATA RECORDING

- The defect recording system and defect statistics for aircraft technology used by the CSA
A75-23047

DATA SYSTEMS

- Evolution of the Douglas flight-test data system
A75-23888
- An integrated PCM data system for full scale aeronautics testing --- common data bases for user requirements
A75-23902

DATA TRANSMISSION

- Data transmission by optical fibers aboard aircraft
A75-23855

DC 8 AIRCRAFT

- FAA JT3D quiet nacelle retrofit feasibility program. Volume 4: Compatibility analysis and design study for DC-8 aircraft
[AD-783187] A75-17357

DC 9 AIRCRAFT

- The measurement of the McDonnell-Douglas DC-9 trailing vortex system using the tower fly-by technique
[AD-A001456/3] A75-18222

DC 10 AIRCRAFT

- Effect of forward motion on fan noise
[AIAA PAPER 75-464] A75-25740

DECISION MAKING

- Decision-making model for ATC system improvement
A75-24754

DEFENSE PROGRAM

- Aerospace technology - Planning methodology and defense-technological objectives
[DGLR PAPER 74-67] A75-24130

DELTA WINGS

- The effect of initial values on wing form and the limiting curve of the wave drag coefficients of optimized symmetrical-thick delta wings in supersonic flow
A75-23100
- Fly-by-wire delta-canard configurations save weight
[SANE PAPER SWR 3] A75-24345
- An experimental investigation of noise-shielding effects for a delta-winged aircraft in flight, wind tunnel and anechoic room
[AIAA PAPER 75-513] A75-25779
- Some aspects of Hybrid-Zeppelins --- with slender delta wing
A75-26008
- Low-speed wind-tunnel tests on the lift-dependant drag of delta wings with conical camber
[ARC-CP-1293] A75-17306

SUBJECT INDEX

- A prediction method for pressure distributions on compression surfaces of conical bodies at supersonic speeds --- delta wings, conical bodies, and two dimensional flow
[ARC-CP-1295] A75-17307
- DESIGN ANALYSIS**
Nonintrusive ultrasonic measurement of flow velocity and mass flow rate
A75-22880
- AFTI TI-1 program --- Advanced Fighter Technology Integration
[SAE PAPER 740860] A75-22939
- A new biaxial testing machine
A75-24068
- The design of flight control devices with the aid of modern system theory
[DGLR PAPER 74-77] A75-24134
- Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings
A75-25969
- Effect of present technology on airship capabilities
A75-25974
- LTA structures and materials technology --- airships
A75-25991
- Design aspects of zeppelin operations from case histories
A75-25994
- The application of the airship to regions lacking in transport infrastructure
A75-26012
- A practical concept for powered or tethered weight-lifting LTA vehicles
A75-26022
- A revolutionary and operational tethered aerostat system illustrating new LTA technology
A75-26023
- System design of a rudder coordination system --- optimization computer program
[NASA-CR-142245] A75-18223
- DIFFERENCE EQUATIONS**
Matrix difference equation analysis of vibrating periodic structures --- aircraft engine parts
A75-23201
- DIFFUSION FLAMES**
The convergence of theory and experiment in direct combustion generated noise
[AIAA PAPER 75-522] A75-25786
- DIGITAL COMPUTERS**
The use of digital computers in air traffic control
A75-25862
- Digital implementation of the TP30-P-3 turbofan engine control
[NASA-TN-X-3105] A75-18239
- DIGITAL SYSTEMS**
Digital avionics - An established technology
A75-24049
- Control and program technology for the implementation of digital flight control systems
[DGLR PAPER 74-81] A75-24138
- Analysis and preliminary design of an advanced technology transport flight control system
[NASA-CR-2490] A75-17295
- Description and flight test results of the NASA F-8 digital fly-by-wire control system
[NASA-TN-D-7843] A75-18245
- An overview of NASA's digital fly-by-wire technology development program
A75-18246
- Design and development experience with a digital fly-by-wire control system in an F-8C airplane
A75-18247
- Mechanization of and experience with a triplex fly-by-wire backup control system
A75-18248
- Man-rated flight software for the F-8 DFBW program
A75-18250
- Flight test experience with the F-8 digital fly-by-wire system
A75-18251
- DISPLAY DEVICES**
Flexibility objectives for real-time telemetry processing systems --- four block model
A75-23887
- Head-up and other displays
A75-24050
- Pilot control/display factors for helicopters
/PIFAX-H/
A75-25070

SUBJECT INDEX

EMERGENCIES

A procedure for the design of multifunction switching controls
[AD-A000532] N75-17354

A laser-generated visual display and tracking task for a link GAT-1 flight trainer
[AD-A001079] N75-17391

DO-31 AIRCRAFT
The significance of aerodynamic jet interference in development and testing of the Do 31 V/STOL transport
[NASA-TT-F-16165] N75-17335

DOUGLAS AIRCRAFT
Evolution of the Douglas flight-test data system
A75-23888

DRAG REDUCTION
Low-speed wind-tunnel tests on the lift-dependent drag of delta wings with conical camber
[ARC-CP-1293] N75-17306

Effect of drag-reducing polymer injection on the lift and drag of a two-dimensional hydrofoil
[AD-A000262] N75-17624

DROP TESTS
Effects of fatigue and dynamic recovery on rain erosion --- plastic coatings and composite materials tests
A75-25189

DYNAMIC CHARACTERISTICS
The steady state and dynamic behaviour of the turbo-bearing
A75-23615

DYNAMIC RESPONSE
The response of a vibrating structure as a function of structural parameters
A75-22796

Diagonalization of the bearing matrix - A systematic method for the analysis of rotor-bearing dynamics
A75-23614

Development of an analysis for the determination of coupled helicopter rotor/control system dynamic response. Part 1: Analysis and applications
[NASA-CR-2452] N75-18178

DYNAMIC STRUCTURAL ANALYSIS
Aeroelasticity of plates and shells --- Book
A75-25180

Studies on the impact structural damage of composite blades
A75-25240

E

ECONOMIC ANALYSIS
Development trends in aircraft design --- economic analysis
[DGLR PAPER 74-68] A75-24131

Breaking with tradition --- airlines economic efficiency
A75-25125

Process of selection and quantization in the case of the fleet of Iberia
A75-25863

Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings
A75-25969

Basic relationships for LTA economic analysis
A75-25971

Comparative airship economics --- design and freight transport factors
A75-25973

An economic comparison of three heavy lift airborne systems
A75-25978

An approach to market analysis for lighter than air transportation of freight
A75-25979

ECONOMIC DEVELOPMENT
Advanced subsonic transports - A challenge for the 1990's
[AIAA PAPER 75-304] A75-23251

ECONOMIC FACTORS
Mobile lounge or fixed gate --- airport terminal design
A75-25343

EIGENVALUES
Diagonalization of the bearing matrix - A systematic method for the analysis of rotor-bearing dynamics
A75-23614

EIGENVECTORS
Diagonalization of the bearing matrix - A systematic method for the analysis of rotor-bearing dynamics
A75-23614

EJECTION SEATS
Navy Aircrew Escape Propulsion System Program
A75-25054

Ejection seat steering and control
A75-25067

ELASTIC PROPERTIES
Stability theory and its applications to structural mechanics --- Book
A75-25181

ELASTOPLASTICITY
Stress-strain state and springback in elastic-plastic torsion of profiles with open cross section contour
A75-23809

ELECTRIC CONTROL
Aircraft control surface actuators --- Russian book
A75-23423

ELECTRIC FIELDS
Electrostatic vertical sensing and control concept for aircraft escape systems
A75-25068

ELECTRIC POWER SUPPLIES
VSCF starter generator --- variable speed constant frequency cycloconverter for aircraft applications
A75-23594

Special problems and capabilities of high altitude lighter than air vehicles --- superpressure powered aerostat design
A75-26021

Study of solid state remote control techniques as applied to the redesign of the electrical system in a large civil aircraft
[ARC-CP-1289] N75-17364

ELECTRIC SWITCHES
Aircraft switching devices: Fabrication technology and installation --- Russian book
A75-23369

A procedure for the design of multifunction switching controls
[AD-A000532] N75-17354

ELECTROCHEMICAL MACHINING
Areas of ECM application, opportunities and limitations --- electrochemical machining technology
A75-23693

ELECTROMAGNETIC RADIATION
The effects of lightning on digital flight control systems
N75-18249

ELECTROMAGNETIC SHIELDING
Measurement of advanced composition materials shielding effectiveness
[AD-A000414] N75-17425

ELECTROMECHANICAL DEVICES
Aircraft switching devices: Fabrication technology and installation --- Russian book
A75-23369

ELECTROMECHANICS
Method of electromechanical simulation of the elastic oscillations of an aircraft in flight
[AD-A000645] N75-17385

ELECTRONIC CONTROL
Instrumentation and control system for an F-15 stall/spin
[NASA-TM-X-72647] N75-17353

ELECTRONIC EQUIPMENT
Three-axis fluidic/electronic automatic flight control system flight test report
[AD-A000894] N75-17379

ELEVATION ANGLE
Millimeter radar for low angle tracking
A75-26038

EMERGENCIES
Emergency and disaster plans, and associated problems concerning major aircraft accidents
A75-25069

EMERGENCY LIFE SUSTAINING SYSTEMS

SUBJECT INDEX

EMERGENCY LIFE SUSTAINING SYSTEMS

Corporate/executive aircraft passenger safety - An educational approach A75-25874

ENERGY ABSORPTION
A crashworthy armored helicopter crew seat A75-25055

ENERGY CONSUMPTION
Documenting helicopter operations from an energy standpoint [NASA-CR-132578] N75-18220

ENERGY DISSIPATION
'Ring vortex' energy losses during centrifugal fan operation in low output regimes A75-23806

ENERGY TECHNOLOGY
The aerospace developments concept --- airship design for natural gas transport A75-26000

ENERGY TRANSFER
Stationary reaction of a dual-sphere configuration moving in a free-molecular medium --- heat and energy transfer in rarefied gases [REPT-36/1973] N75-18172

ENGINE CONTROL
Digital implementation of the TF30-P-3 turbofan engine control [NASA-TM-X-3105] N75-18239

ENGINE DESIGN
Areas of ECM application, opportunities and limitations --- electrochemical machining technology A75-23693
Analytic specification of compressor characteristics A75-23816
Developmental programs for small expendable turbojets A75-24946
Preliminary study of advanced turbofans for low energy consumption [NASA-TM-X-71663] N75-18241

ENGINE FAILURE
Impact response of graphite-epoxy flat laminates using projectiles that simulate aircraft engine encounters A75-25232
Engine failure prediction techniques A75-25274

ENGINE INLETS
Development of the inlet ramp of a supersonic aircraft, employing a design which utilizes a fiber composite material [DGLR PAPER 74-120] A75-24157
Concorde inlet system and peripheral envelope flight testing A75-24804
Design of a very-low-bleed Mach 2.5 mixed-compression inlet with 45 percent internal contraction [NASA-TM-X-3135] N75-17363

ENGINE NOISE
Propagation of sound in elliptic ducts A75-22791
Measurement and prediction of jet noise in flight [AIAA PAPER 75-461] A75-25738
Simulation of flight effects on aero engine fan noise [AIAA PAPER 75-463] A75-25739
Effect of forward motion on fan noise [AIAA PAPER 75-464] A75-25740
Model and full scale test results relating to fan noise in-flight effects [AIAA PAPER 75-465] A75-25741
The noise behaviour of aero engine turbine tones [AIAA PAPER 75-466] A75-25742
Acoustic characteristics of a large upper-surface blown configuration with turbofan engines [AIAA PAPER 75-473] A75-25748
Noise shielding effects for engine-over-wing installations [AIAA PAPER 75-474] A75-25749
Minimization of jet and core noise of a turbojet engine by swirling the exhaust flow [AIAA PAPER 75-503] A75-25769
Cross-correlation of noise produced inside a hot turbojet exhaust with and without suppression using a new, hot probe [AIAA PAPER 75-505] A75-25771

Acoustic wave propagation in a lined duct with non-uniform admittance [AIAA PAPER 75-515] A75-25781
The convergence of theory and experiment in direct combustion generated noise [AIAA PAPER 75-522] A75-25786
An experimental investigation of the core engine noise of a turbofan engine [AIAA PAPER 75-526] A75-25790
Core engine noise due to temperature fluctuations convecting through turbine blade rows [AIAA PAPER 75-528] A75-25791
Aircraft flyover noise measurements [AIAA PAPER 75-537] A75-25799
Review of theory and methods for turbine noise prediction [AIAA PAPER 75-540] A75-25802
Review of theory and methods for combustion noise prediction [AIAA PAPER 75-541] A75-25803
Broadband noise generated by turbulent inflow to rotor or stator blades in an annular duct [NASA-CR-2503] N75-17361
Some questions on the creation of an open stand for acoustic investigations of DTRD's --- development of facilities for testing turbofan engines [AD-A000660] N75-17365
Noise reduction studies for the OV-1 airplane [NASA-TM-X-72639] N75-18232
Ground noise measurements during static and flyby operations of the Cessna 02-T turbine powered airplane [NASA-TM-X-72642] N75-18234
Noise reduction studies of several aircraft to reduce their aural detection distances [NASA-TM-X-72644] N75-18235

ENGINE PARTS
Automatic Test System Jet Engine Accessories A75-23649

ENGINE STARTERS
VSCF starter generator --- variable speed constant frequency cycloconverter for aircraft applications A75-23594

ENGINE TESTS
Altitude evaluation of a variable cycle turbofan engine [SAE PAPER 740806] A75-22938
Automatic Test System Jet Engine Accessories A75-23649
Emission calibration of a J-58 afterburning turbojet engine at simulated supersonic, stratospheric flight conditions A75-23964
Recent progress in experimental studies of afterbodies A75-24943
Simulation of flight effects on aero engine fan noise [AIAA PAPER 75-463] A75-25739
An experimental investigation of the core engine noise of a turbofan engine [AIAA PAPER 75-526] A75-25790

ENTROPY
Entropy layer on a supersonic plane flat nose at incidence A75-23208

ENVELOPES
Computer aided flexible envelope designs A75-25989

ENVIRONMENT MODELS
Airport noise abatement - How effective can it be A75-23125

ENVIRONMENT PROTECTION
Methods for the determination of noise protection areas in accordance with the law for protection against aircraft noise [DGLR PAPER 74-110] A75-24150

ENVIRONMENTAL CONTROL
Exploitation of air conditioning systems for passenger aircraft --- Russian book A75-23375

EQUATIONS OF MOTION
The planar dynamics of airships A75-25986

EROSION
A model for rain erosion of homogeneous materials --- mass loss estimation A75-25185

- Influence of velocity, impingement angle, heating, and aerodynamic shock layers on erosion of materials at velocities of 5500 ft per s /1700 m per s/ A75-25188
- Effects of fatigue and dynamic recovery on rain erosion --- plastic coatings and composite materials tests A75-25189
- ERROR ANALYSIS**
- Analysis of frequency error of airplane descent rate measured by a laser A75-23797
- Monte Carlo analysis of inaccuracies in estimated aircraft parameters caused by unmodeled flight, instrumentation errors [NASA-TN-D-7712] N75-17368
- ESCAPE SYSTEMS**
- Navy Aircrew Escape Propulsion System Program A75-25054
- Ejection seat steering and control A75-25067
- Electrostatic vertical sensing and control concept for aircraft escape systems A75-25068
- ESTIMATES**
- Development of a non-survey method estimating traffic at nontowered airports [AD-A002397] N75-18263
- ESTIMATING**
- Target identification by natural resonance estimation --- radar signatures A75-25878
- EXHAUST GASES**
- Measurements of supersonic jet aircraft wakes in the stratosphere A75-23962
- Simulation of hypersonic scramjet exhaust --- pressure distribution on afterbody/nozzle sections of vehicle [NASA-CR-2494] N75-17344
- Prevaporization and premixing to obtain low oxides of nitrogen in gas turbine combustors [NASA-CR-2495] N75-17362
- Engineering and development program plan: Aircraft propulsion systems air pollution [AD-777484] N75-17835
- EXHAUST NOZZLES**
- Recent advances in exhaust systems for jet noise suppression of high speed aircraft [AIAA PAPER 75-333] A75-25016
- Experimental investigation of the aeroacoustic characteristics of model slot nozzles with straight flaps [AIAA PAPER 75-471] A75-25746
- The effects of forward speed on a number of turbojet exhaust silencers [AIAA PAPER 75-506] A75-25772
- EXTERNAL STORES**
- Analysis and design of a multiaxis vibration isolator for missile pods mounted on Army helicopters [AD-A001459] N75-18225
- EXTERNALLY BLOWN FLAPS**
- Scrubbing noise of externally blown flaps [AIAA PAPER 75-469] A75-25745
- Experimental investigation of the aeroacoustic characteristics of model slot nozzles with straight flaps [AIAA PAPER 75-471] A75-25746
- Fluctuating pressures on aircraft wing and flap surfaces associated with powered-lift systems [AIAA PAPER 75-472] A75-25747
- Forward velocity effects on under-the-wing externally blown flap noise [AIAA PAPER 75-476] A75-25750
- Wind tunnel investigation of aerodynamic loads on a large-scale externally blown flap model and comparison with theory [NASA-TN-D-7863] N75-17294
- Wind tunnel investigation of the wake near the trailing edge of a distributed upper-surface-blown flap [NASA-TN-X-72637] N75-18176
- Static and wind tunnel model tests for the development of externally blown flap noise reduction techniques [NASA-CR-134675] N75-18177
- F**
- F-4 AIRCRAFT**
- F-4/CCV-flight tests of advanced technology [SAE PAPER 740861] A75-22940
- F-8 AIRCRAFT**
- Description and flight test results of the NASA F-8 digital fly-by-wire control system [NASA-TN-D-7843] N75-18245
- An overview of NASA's digital fly-by-wire technology development program N75-18246
- Design and development experience with a digital fly-by-wire control system in an F-8C airplane N75-18247
- Mechanization of and experience with a triplex fly-by-wire backup control system N75-18248
- Man-rated flight software for the F-8 DPBW program N75-18250
- Flight test experience with the F-8 digital fly-by-wire system N75-18251
- A pilot's opinion of the F-8 digital fly-by-wire airplane N75-18252
- F-15 AIRCRAFT**
- F-15 secondary power systems [SAE PAPER 740885] A75-22948
- F-15 update report A75-24806
- Instrumentation and control system for an F-15 stall/spin [NASA-TN-X-72647] N75-17353
- F-16 AIRCRAFT**
- F-16 flight test program - Lightweight fighter program A75-24808
- F-17 AIRCRAFT**
- F-17 flight test program - Lightweight fighter program A75-24809
- FABRICATION**
- N/C tape laying - Tomorrow's future today --- for helicopter rotor blade manufacturing [SME PAPER MS74-729] A75-23441
- FAILURE ANALYSIS**
- Methods of inspecting and preventing work defects during maintenance --- of aircraft A75-23049
- Engine failure prediction techniques A75-25274
- FAIRINGS**
- Effects of nozzle interfairing modifications on longitudinal aerodynamic characteristics of a twin jet, variable wing sweep fighter model [NASA-TN-D-7817] N75-18180
- FANS**
- Model and full scale test results relating to fan noise in-flight effects [AIAA PAPER 75-465] A75-25741
- FAR FIELDS**
- Jet noise source location by cross-correlation of far field microphone signals [AIAA PAPER 75-456] A75-25737
- Aircraft far-field aerodynamic noise - Its measurement and prediction [AIAA PAPER 75-486] A75-25756
- FATIGUE (MATERIALS)**
- A model for rain erosion of homogeneous materials --- mass loss estimation A75-25185
- FATIGUE LIFE**
- On stress in service condition and estimated fatigue life of blades in axial flow compressor A75-23152
- FATIGUE TESTS**
- Effects of fatigue and dynamic recovery on rain erosion --- plastic coatings and composite materials tests A75-25189
- FEASIBILITY ANALYSIS**
- RTOL and steep approach - Why [DGLR PAPER 74-112] A75-24152
- Ejection seat steering and control A75-25067

FEEDBACK CONTROL

SUBJECT INDEX

- The effects of selected modern technological concepts on the performance and handling characteristics of LTA vehicles
A75-25982
- Lighter than air - A look at the past, a look at the possibilities
A75-25995
- A revolutionary and operational tethered aerostat system illustrating new LTA technology
A75-26023
- ASR-5 radar dual feedhorn antenna modification. Volume 1: Description of hardware and summary of feasibility effort
[AD-781348]
N75-17573
- FEEDBACK CONTROL**
Multilevel control optimization using subsystem relative performance index sensitivity
A75-25098
- FIBER OPTICS**
Data transmission by optical fibers aboard aircraft
A75-23855
- FIGHTER AIRCRAFT**
AFTI TI-1 program --- Advanced Fighter Technology Integration
[SAE PAPER 740860]
A75-22939
- F-15 secondary power systems
[SAE PAPER 740885]
A75-22948
- The technology of the aircraft MRCA and its systems
[DGLR PAPER 74-63]
A75-24129
- Problems and implementation possibilities of a direct side force control in the case of fighters
[DGLR PAPER 74-84]
A75-24140
- Low speed wind tunnel test of jet flaps and floating wingtip ailerons on a fighter wing
[AD-A000809]
N75-17318
- AN/ASN-90 systems improvement program --- for analysis of operational performance and operational maintenance
[AD-A001647]
N75-17333
- Landing impact studies of a 0.3-scale model air cushion landing system for a Navy fighter airplane
[NASA-TN-D-7875]
N75-17342
- Effects of nozzle interfairing modifications on longitudinal aerodynamic characteristics of a twin jet, variable wing sweep fighter model
[NASA-TN-D-7817]
N75-18180
- FILM COOLING**
Preliminary experiments on film cooling of turbine blades with injection near the leading edge. 1: Injection through holes located near the leading edge
[NAL-TR-371]
N75-17359
- FINITE DIFFERENCE THEORY**
Numerical solutions for supersonic corner flow
A75-23295
- Generalized wave envelope analysis of sound propagation in ducts with stepped noise source profiles and variable axial impedance
[AIAA PAPER 75-518]
A75-25784
- Application of a variational method in plane compressible flow calculation --- steady inviscid plane subsonic flow past an airfoil
[ABC-CP-1284]
N75-17303
- FINITE ELEMENT METHOD**
Finite element flutter analysis of multi-web wing structures
A75-22795
- Substantiation of discrete-continuum low-aspect-ratio wing structural analysis scheme
A75-23798
- Static computation of a wing model made of carbon fiber reinforced plastic /bending-torsion box/ with the aid of the method of finite elements and a comparison with experimental values
[DGLR PAPER 74-118]
A75-24155
- A finite element approach to the aeroelastic analysis of lifting surface type structures
A75-24918
- An iterative improvement for finite element analysis
A75-25212
- FIRE CONTROL**
Design analysis of helicopter automatic and semiautomatic airborne precision pointing and tracking systems
[AD-A000834]
N75-18229
- FIRE EXTINGUISHERS**
Fire-fighting in airport premises
A75-25342
- Evaluation of a high-capacity, firefighting foam-dispensing system
[AD-A006264]
N75-18259
- FIRE FIGHTING**
Fire-fighting in airport premises
A75-25342
- Evaluation of a high-capacity, firefighting foam-dispensing system
[AD-A006264]
N75-18259
- FLAME HOLDERS**
Combustion intensity and distribution relation to noise generation
[AIAA PAPER 75-524]
A75-25788
- FLAPPING**
Flapping response characteristics of hingeless rotor blades by a generalized harmonic balance method
[NASA-TN-D-7856]
N75-18183
- FLAPS (CONTROL SURFACES)**
Application of the equivalent mechanical flap concept to jet flapped wing-body combinations
[AD-A000431]
N75-17346
- FLAT PLATES**
Hypersonic viscous slip flow over an insulated flat plate with real gas effects
A75-23205
- Stall flutter and nonlinear divergence of a two-dimensional flat plate wing
[AD-A000569]
N75-17314
- FLAT SURFACES**
Entropy layer on a supersonic plane flat nose at incidence
A75-23208
- FLEXIBLE BODIES**
Computer aided flexible envelope designs
A75-25989
- Airfoil optimization utilizing a remotely controlled flexible model. Phase 1: Low speed wind tunnel test
[AD-A001094]
N75-18189
- FLIGHT CHARACTERISTICS**
Design aspects of zeppelin operations from case histories
A75-25994
- Flight control systems properties and problems, volume 1
[NASA-CR-2500]
N75-17371
- Flight control systems properties and problems. Volume 2: Block diagram compendium
[NASA-CR-2501]
N75-17372
- FLIGHT CONTROL**
Results of the investigation regarding two three-dimensional low-level flight control systems
[DGLR PAPER 74-83]
A75-24139
- Modern control - Modeling and application in real aircraft flight control system design
A75-24758
- Air traffic control
A75-25861
- VTOL flight-control system design using sensitivity analysis
A75-25879
- State of the art of metalclad airships
A75-25999
- Analysis and preliminary design of an advanced technology transport flight control system
[NASA-CR-2490]
N75-17295
- Input design for identification of aircraft stability and control derivatives
[NASA-CR-2493]
N75-17370
- Flight control systems properties and problems, volume 1
[NASA-CR-2500]
N75-17371
- Flight control systems properties and problems. Volume 2: Block diagram compendium
[NASA-CR-2501]
N75-17372
- Effects of time-shifted data on flight determined stability and control derivatives
[NASA-TN-D-7830]
N75-18244
- FLIGHT HAZARDS**
Flight test investigation of the vortex wake characteristics behind a Boeing 727 during two-segment and normal ILS approaches (A joint NASA/PAA report)
[NASA-TN-X-62398]
N75-17340
- The effects of lightning on digital flight control systems
N75-18249

FLIGHT INSTRUMENTS

The design of flight control devices with the aid of modern system theory
[DGLR PAPER 74-77] A75-24134
Monte Carlo analysis of inaccuracies in estimated aircraft parameters caused by unmodeled flight instrumentation errors
[NASA-TN-D-7712] N75-17368

FLIGHT MECHANICS

Handbook for aircraft mechanics /3rd revised and enlarged edition/
A75-23366
The design and construction of the CAD-1 airship
--- Canadian Airship Development A75-26002

FLIGHT PATHS

Pilot preference and procedures at uncontrolled airports
[NASA-TN-D-7928] N75-18169

FLIGHT PLANS

Connection between the flight plan and the repair hangar control plan and its meaning for the quality of the transport process
A75-23043

Air traffic control
A75-25861

FLIGHT RECORDERS

The civil aircraft airworthiness data recording programme. A study of normal operational landing performance on subsonic civil jet aircraft
[ARC-CP-1273] N75-17320

FLIGHT SAFETY

Technology for improved safety --- for general aviation
[AIAA PAPER 75-291] A75-25008
Survival and Flight Equipment Association, Annual Conference and Trade Exhibit, 12th, Las Vegas, Nev., September 8-12, 1974, Proceedings
A75-25051

Surveillance velocity measurements with least maximum error
A75-25928

Status of the wake vortex avoidance system --- in terminal airspace
A75-26060

Study of alternative beacon based surveillance and data link systems, volume 2
[AD-772136] N75-17325

FLIGHT SIMULATION

Hydrocarbon emissions from jet engines operated at simulated high-altitude supersonic flight conditions
A75-23963

Emission calibration of a J-58 afterburning turbojet engine at simulated supersonic, stratospheric flight conditions
A75-23964

Simulation of flight effects on aero engine fan noise
[AIAA PAPER 75-463] A75-25739

Model and full scale test results relating to fan noise in-flight effects
[AIAA PAPER 75-465] A75-25741

Simulation of hypersonic scramjet exhaust --- pressure distribution on afterbody/nozzle sections of vehicle
[NASA-CR-2494] N75-17344

Aircraft flutter simulation by means of the electronic analogue computer with special regard to structural nonlinearities
[ESRO-TT-121] N75-17384

FLIGHT SIMULATORS

Method of electromechanical simulation of the elastic oscillations of an aircraft in flight
[AD-A000645] N75-17385

A laser-generated visual display and tracking task for a link GAT-1 flight trainer
[AD-A001079] N75-17391

Engineering simulation development and evaluation of the two-segment noise abatement approach conducted in the B-727-222 flight simulator
[NASA-CR-137594] N75-18195

Man-rated flight software for the F-8 DFBW program
N75-18250

The flight investigation and analysis of longitudinal handling qualities of STOL aircraft on landing approach
[AD-A001596] N75-18254

FLIGHT STABILITY TESTS

Report on spin test of AJ37 Viggen
A75-24807

Evaluation of the effect of a yaw-rate damper on the lateral-directional stability and control of the Beechcraft Queen Air 80 laboratory aircraft
[NLR-TR-73105-U] N75-17374

FLIGHT STRESS

Vertical seeking ejection seat
A75-25053

FLIGHT TESTS

F-4/CCV-flight tests of advanced technology
[SAE PAPER 740861] A75-22940
Evolution of the Douglas flight-test data system
A75-23888

1974 report to the aerospace profession; Proceedings of the Eighteenth Symposium, Beverly Hills, Calif., September 25-28, 1974
A75-24802

Concorde inlet system and peripheral envelope flight testing
A75-24804

Recent wake turbulence flight test programs
A75-24805

F-15 update report
A75-24806

YF-16 flight test program - Lightweight fighter program
A75-24808

YF-17 flight test program - Lightweight fighter program
A75-24809

Measurements and analysis of aircraft airframe noise
[AIAA PAPER 75-510] A75-25776
Laterally displaced ISLS antenna for tactical radar
--- Interrogation Side Lobe Suppression
A75-25926

An LTA flight research vehicle --- airship development
A75-26003

FLIGHT VEHICLES

The future application of aircraft-borne digital computers in complex-automated adaptive control systems for flight vehicles
[AD-A000193] N75-18253

FLOW CHARACTERISTICS

Calculation by the singularity method of the characteristics of a cascade in compressible flow without knocking up to the supercritical speed
A75-23988

Low Reynolds number hypersonic nozzle flows
A75-24270

FLOW DIRECTION INDICATORS

Miniature probe for transonic flow direction measurements
A75-23224

FLOW DISTORTION

Effect of geometry on open cavity flow-induced pressure oscillations
[AIAA PAPER 75-492] A75-25761

FLOW DISTRIBUTION

Supersonic flow of a lightly dust-laden gas past a wedge
A75-23298

Combustion intensity and distribution relation to noise generation
[AIAA PAPER 75-524] A75-25788

Wind tunnel investigation of the wake near the trailing edge of a distributed upper-surface-blown flap
[NASA-TN-X-72637] N75-18176

FLOW EQUATIONS

Transonic profile design --- gas dynamic analysis
[DGLR PAPER 74-98] A75-24145

FLOW GEOMETRY

Sound propagation in curved ducts
[AIAA PAPER 75-497] A75-25766

FLOW MEASUREMENT

Averaging of nonuniform flow in turbomachine flow traverses
A75-23821

Flow determination at the exit of a moving supersonic annular blade cascade
[ONERA, TP NO. 1370] A75-23946

Experimental study of the unsteady flow through a turbomachine stage
A75-23947

FLOW STABILITY

SUBJECT INDEX

- The FOP wind tunnel --- Field Observing Facility
anemometer calibrations A75-24395
- FLOW STABILITY**
The scattering of sound by a vortex sheet A75-22934
- FLOW THEORY**
Approximate solution to the wing theory equation
by the Bubnov-Galerkin method A75-24833
- FLOW VELOCITY**
Nonintrusive ultrasonic measurement of flow
velocity and mass flow rate A75-22880
- FLOW VISUALIZATION**
The measurement of the McDonnell-Douglas DC-9
trailing vortex system using the tower fly-by
technique [AD-A001456/3] N75-18222
- FLOWMETERS**
Nonintrusive ultrasonic measurement of flow
velocity and mass flow rate A75-22880
Ultrasonic flowmeter cell designs for liquids A75-25951
- FLUID FLOW**
Turbulent wake behind slender bodies including
self-propelled configurations [AD-A001040] N75-17319
- FLUID INJECTION**
Skin friction reduction in supersonic flow by
injection through slots, porous sections and
combinations of the two [NASA-CR-2491] N75-17614
- FLUID SWITCHING ELEMENTS**
Three-axis fluidic/electronic automatic flight
control system flight test report [AD-A000894] N75-17379
- FLUIDICS**
Fluidic ejection seat control system A75-25052
- FLUORESCENCE**
Survey of thin film fluorescent material --- for
marking aircraft [AD-A005571] N75-18194
- FLUTTER**
A curve fitting method for solving the flutter
equation [NASA-CR-132629] N75-17341
Method of electromechanical simulation of the
elastic oscillations of an aircraft in flight
[AD-A000645] N75-17385
- FLUTTER ANALYSIS**
Finite element flutter analysis of multi-web wing
structures A75-22795
Fundamental frequency of a square panel with
multiple point supports on edges A75-22798
Calculation of flutter boundary of dynamically
nonuniform profile cascades A75-23819
A finite element approach to the aeroelastic
analysis of lifting surface type structures A75-24918
Stall flutter and nonlinear divergence of a
two-dimensional flat plate wing [AD-A000569] N75-17314
Aircraft flutter simulation by means of the
electronic analogue computer with special regard
to structural nonlinearities [ESRO-TT-121] N75-17384
Optimization of structures to satisfy a flutter
velocity constraint by use of quadratic equation
fitting [NASA-CR-132628] N75-17711
Flutter suppression and gust alleviation using
active controls [NASA-CR-142195] N75-18243
- FLY BY WIRE CONTROL**
F-4/CCV-flight tests of advanced technology
[SAE PAPER 740861] A75-22940
Aircraft control surface actuators --- Russian book
A75-23423
Fly-by-wire delta-canard configurations save weight
[SAE PAPER SWR 3] A75-24345
Description and flight test results of the NASA
F-8 digital fly-by-wire control system [NASA-TN-D-7843] N75-18245
- An overview of NASA's digital fly-by-wire
technology development program N75-18246
- Design and development experience with a digital
fly-by-wire control system in an F-8C airplane
N75-18247
- Mechanization of and experience with a triplex
fly-by-wire backup control system N75-18248
- The effects of lightning on digital flight control
systems N75-18249
- Man-rated flight software for the F-8 DFBW program
N75-18250
- Flight test experience with the F-8 digital
fly-by-wire system N75-18251
- A pilot's opinion of the F-8 digital fly-by-wire
airplane N75-18252
- FLYING EJECTION SEATS**
Fluidic ejection seat control system A75-25052
Vertical seeking ejection seat A75-25053
- FOAMS**
Evaluation of a high-capacity, firefighting
foam-dispensing system [AD-A006264] N75-18259
- FORCED VIBRATION**
The response of a vibrating structure as a
function of structural parameters A75-22796
Matrix difference equation analysis of vibrating
periodic structures --- aircraft engine parts
A75-23201
- FORECASTING**
Forecasting traffic in an air transport network
A75-24341
- FRACTURE STRENGTH**
Combining strength and fracture toughness ---
vacuum arc melted steels for aerospace
applications A75-24002
Fracture mechanics' impact on specifications and
supply --- test methods for aircraft aluminum
alloys A75-24004
- FREE FLOW**
The structure and dynamics of vortex filaments ---
in aircraft wakes A75-24481
- FREE MOLECULAR FLOW**
Stationary reaction of a dual-sphere configuration
moving in a free-molecular medium --- heat and
energy transfer in rarefied gases [REPT-36/1973] N75-18172
- FREIGHT COSTS**
An approach to market analysis for lighter than
air transportation of freight A75-25979
The transport of nuclear power plant components
A75-26016
- FREQUENCY ASSIGNMENT**
Aero-marine communications by satellite A75-24100
- FREQUENCY RESPONSE**
Discrete frequency rotor noise --- from helicopters
[AIAA PAPER 75-451] A75-25733
The noise behaviour of aero engine turbine tones
[AIAA PAPER 75-466] A75-25742
- FRICTION REDUCTION**
Skin friction reduction in supersonic flow by
injection through slots, porous sections and
combinations of the two [NASA-CR-2491] N75-17614
- FRICTIONLESS ENVIRONMENTS**
Contribution to the study of supercritical profile
flow [DGLR PAPER 74-99] A75-24146
- FUEL COMBUSTION**
The convergence of theory and experiment in direct
combustion generated noise [AIAA PAPER 75-522] A75-25786
Combustion intensity and distribution relation to
noise generation [AIAA PAPER 75-524] A75-25788

Review of theory and methods for combustion noise prediction
[AIAA PAPER 75-541] A75-25803

FUEL CONSUMPTION
Future long-range transports: Prospects for improved fuel efficiency
[NASA-TM-X-72659] N75-17339

FUEL CONTROL
Automatic Test System Jet Engine Accessories A75-23649
Digital implementation of the TF30-P-3 turbofan engine control
[NASA-TM-X-3105] N75-18239

FUEL FLOW
Ultrasonic flowmeter cell designs for liquids A75-25951

FUEL SYSTEMS
Fuelling systems --- at airports A75-25275

FUEL TANK PRESSURIZATION
Fuelling systems --- at airports A75-25275

FUEL TANKS
Catalytic reactor for inerting of aircraft fuel tanks
[AD-A000939] N75-18228

FUEL TESTS
Laboratory evaluation of the stability of high-purity jet fuels of the T-8 type and of the effectiveness of antioxidants A75-24274

FULL SCALE TESTS
An integrated PCM data system for full scale aeronautics testing --- common data bases for user requirements A75-23902
A preliminary investigation of remotely piloted vehicles for airframe noise research
[AIAA PAPER 75-512] A75-25778

FUSELAGES
Stress analysis of aircraft fuselages and pressurized cabins --- Russian book A75-23231
Analysis of thin-wall circular fuselage in damage zone A75-23801
A spatial theory for the ground resonance of helicopters --- noting fuselage rotation degrees of freedom
[ESRO-TT-108] N75-17297
Aerodynamic testing technique for twin fuselage models at hypersonic speeds
[NASA-TM-X-3196] N75-18187
Acoustic transmission through a fuselage sidewall
[NASA-CR-132602] N75-18971

G

GALERKIN METHOD
Approximate solution to the wing theory equation by the Bubnov-Galerkin method A75-24833
Approximate solution of integral equations with a singular operator --- for wing motion A75-24835

GAS BEARINGS
The steady state and dynamic behaviour of the turbo-bearing A75-23615
Characteristics of air bearings with small inlet holes for a precision coordinate measuring device A75-25715

GAS DYNAMICS
Transonic profile design --- gas dynamic analysis
[DGLR PAPER 74-98] A75-24145

GAS FLOW
Supersonic flow of a lightly dust-laden gas past a wedge A75-23298
Averaging of nonuniform flow in turbomachine flow traverses A75-23821
The determination of the subsonic flow of a Chaplygin gas around a circular profile in the presence of circulation A75-24061

GAS GENERATORS
Factors in the design of solid oxygen systems for aircraft A75-25061
Catalytic reactor for inerting of aircraft fuel tanks
[AD-A000939] N75-18228

GAS TRANSPORT
The aerospace developments concept --- airship design for natural gas transport A75-26000
Method for transporting impellent gases A75-26001

GAS TURBINE ENGINES
Analytic specification of compressor characteristics A75-23816
NASA vane alloy boasts high-temperature strength A75-24003
Coatings protect superalloys in gas-turbine applications A75-24005
Engine failure prediction techniques A75-25274
The convergence of theory and experiment in direct combustion generated noise
[AIAA PAPER 75-522] A75-25786
Prevaporization and premixing to obtain low oxides of nitrogen in gas turbine combustors
[NASA-CR-2495] N75-17362
Ground noise measurements during static and flyby operations of the Cessna 02-T turbine powered airplane
[NASA-TM-X-72642] N75-18234
Technology for reducing aircraft engine pollution
[NASA-TM-X-71670] N75-18237

GAS TURBINES
Thermodynamics of multistage air-cooled gas turbine A75-23817
Hot corrosion in gas turbines A75-24380

GAS-METAL INTERACTIONS
Hot corrosion in gas turbines A75-24380

GENERAL AVIATION AIRCRAFT
NASA general aviation technology programs
[AIAA PAPER 75-290] A75-25007
Technology for improved safety --- for general aviation
[AIAA PAPER 75-291] A75-25008
General aviation safety - Fact and fiction A75-25719
Corporate/executive aircraft passenger safety - An educational approach A75-25874
A semibuoyant vehicle for general transportation missions A75-26006
Application of numerical optimization to the design of low speed airfoils
[NASA-TM-X-3213] N75-18181

GOVERNMENT/INDUSTRY RELATIONS
The institutionalization and the general problems of air traffic A75-23348
Noise legislation and regulations A75-23436

GRAPHITE
Measurement of advanced composition materials shielding effectiveness
[AD-A000414] N75-17425

GROUND BASED CONTROL
Ground-based collision avoidance systems for air traffic A75-26062

GROUND EFFECT
Review of theory and methods for the prediction of ground effects on aircraft noise propagation
[AIAA PAPER 75-538] A75-25800
A new concept for airship mooring and ground handling A75-25997
The effect of ground proximity on the lateral/directional aerodynamic and control characteristics of a tilt-wing V/STOL aircraft at high lift coefficients N75-18227
[AD-A001584]

GROUND EFFECT MACHINES

SUBJECT INDEX

GROUND EFFECT MACHINES

Landing impact studies of a 0.3-scale model air cushion landing system for a Navy fighter airplane [NASA-TN-D-7875] N75-17342
Surface effect takeoff and landing system (SETOLS) [AD-A000101] N75-17345

GROUND HANDLING

Mooring and ground handling rigid airships A75-25996
A new concept for airship mooring and ground handling A75-25997

GROUND SUPPORT EQUIPMENT

Test bed for the upgraded third generation Air Traffic Control System A75-26064

GROUND TESTS

Static structural test for supersonic aircraft --- Russian book A75-23233

GROUND WIND

An experimental simulation study of four crosswind landing gear concepts [NASA-TN-D-7864] N75-18184

GUST ALLEVIATORS

Flutter suppression and gust alleviation using active controls [NASA-CR-142195] N75-18243

GUST LOADS

Gust loads on 707 and VC 10 aircraft [ARC-CP-1281] N75-17373

GYROSCOPES

Laser gyro reaction time investigation program [AD-A001646] N75-17332

H

H-53 HELICOPTER

Ultra-heavy vertical lift system 'The Heli-Stat' --- combined LTA-helicopter design A75-26009

HANDBOOKS

Handbook for aircraft mechanics /3rd revised and enlarged edition/ A75-23366

HANGARS

Connection between the flight plan and the repair hangar control plan and its meaning for the quality of the transport process A75-23043
Observations on the construction and use of airplane hangars A75-23046

HARDWARE

ASR-5 radar dual feedhorn antenna modification. Volume 1: Description of hardware and summary of feasibility effort [AD-781348] N75-17573

HEAD-UP DISPLAYS

Head-up and other displays A75-24050

HEAT RESISTANT ALLOYS

NASA vane alloy boasts high-temperature strength A75-24003
Coatings protect superalloys in gas-turbine applications A75-24005

HEAT SINKS

Study of active cooling for supersonic transports [NASA-CR-132573] N75-17336

HEAT TRANSFER

Stationary reaction of a dual-sphere configuration moving in a free-molecular medium --- heat and energy transfer in rarefied gases [REPT-36/1973] N75-18172

HEAVY LIFT HELICOPTERS

An economic comparison of three heavy lift airborne systems A75-25978

HELICOPTER CONTROL

Pilot control/display factors for helicopters /PIFAX-H/ A75-25070
Development of an analysis for the determination of coupled helicopter rotor/control system dynamic response. Part 1: Analysis and applications [NASA-CR-2452] N75-18178

Flapping response characteristics of hingeless rotor blades by a generalized harmonic balance method [NASA-TN-D-7856] N75-18183

HELICOPTER DESIGN

Ultra-heavy vertical lift system 'The Heli-Stat' --- combined LTA-helicopter design A75-26009

An aeroelastic model helicopter rotor [ARC-CP-1288] N75-17304

HELICOPTER PERFORMANCE

Experimentally verified analytical techniques for predicting vehicle crash response [AIAA PAPER 75-273] A75-25006
A crashworthy armored helicopter crew seat A75-25055

A spatial theory for the ground resonance of helicopters --- noting fuselage rotation degrees of freedom [ESRO-TT-108] N75-17297

Mechanical instability ground dynamics program [AD-A001101] N75-17349

Documenting helicopter operations from an energy standpoint [NASA-CR-132578] N75-18220

Stabilization of externally slung helicopter loads [AD-A000893] N75-18224

HELICOPTERS

H/C tape laying - Tomorrow's future today --- for helicopter rotor blade manufacturing [SME PAPER MS74-729] A75-23441

Helicopter TERPS validation study, phase 1 [AD-A000423] N75-17347

Three-axis fluidic/electronic automatic flight control system flight test report [AD-A000894] N75-17379

Documenting helicopter operations from an energy standpoint [NASA-CR-132578] N75-18220

HIGH ALTITUDE

Hydrocarbon emissions from jet engines operated at simulated high-altitude supersonic flight conditions A75-23963

Stratospheric pollution - Aircraft engine emissions in the region above the tropopause as a function of aircraft altitude and tropopause height A75-23965

HIGH ALTITUDE BALLOONS

Unmanned powered balloons A75-26020

Special problems and capabilities of high altitude lighter than air vehicles --- superpressure powered aerostat design A75-26021

HIGH RESOLUTION

High range-resolution monopulse tracking radar and applications --- for target recognition A75-26041

HIGH STRENGTH ALLOYS

Fracture mechanics' impact on specifications and supply --- test methods for aircraft aluminum alloys A75-24004

HIGH STRENGTH STEELS

Combining strength and fracture toughness --- vacuum arc melted steels for aerospace applications A75-24002

HIGH TEMPERATURE GASES

Hot corrosion in gas turbines A75-24380

Cross-correlation of noise produced inside a hot turbojet exhaust with and without suppression using a new, hot probe [AIAA PAPER 75-505] A75-25771

HODOGRAPHS

Transonic profile design --- gas dynamic analysis [DGLR PAPER 74-98] A75-24145

HORIZONTAL FLIGHT

Aerodynamics of the propellers of rapidly convertible VTOL aircraft A75-24942

HORN ANTENNAS

ASR-5 radar dual feedhorn antenna modification. Volume 1: Description of hardware and summary of feasibility effort [AD-781348] N75-17573

- HOT-FILM ANEMOMETERS**
Experimental determination of the separation point of flow around a circular cylinder
A75-22868
The FOF wind tunnel --- Field Observing Facility anemometer calibrations
A75-24395
- HOVERCRAFT GROUND EFFECT MACHINES**
Preliminary ride-quality evaluation of the HM.2 Hoverferry
[NASA-CR-142290]
N75-17338
- HOVERING**
VTOL flight-control system design using sensitivity analysis
A75-25879
- HOVERING STABILITY**
Report on program to improve MIL-F-83300 --- simulation of short takeoff aircraft longitudinal characteristics
[AD-A001598]
N75-18226
- HULLS (STRUCTURES)**
An aerodynamic load criterion for airships
A75-25985
State of the art of metalclad airships
A75-25999
The variable density aircraft concept
A75-26010
Special problems and capabilities of high altitude lighter than air vehicles --- superpressure powered aerostat design
A75-26021
- HUMAN FACTORS ENGINEERING**
Pilot preference and procedures at uncontrolled airports
[NASA-TN-D-7928]
N75-18169
- HYDRAULIC CONTROL**
Aircraft control surface actuators --- Russian book
A75-23423
- HYDRAULIC EQUIPMENT**
Airfoil optimization utilizing a remotely controlled flexible model. Phase 1: Low speed wind tunnel test
[AD-A001094]
N75-18189
Analysis and design of a multiaxis vibration isolator for missile pods mounted on Army helicopters
[AD-A001459]
N75-18225
- HYDROCARBON COMBUSTION**
Hydrocarbon emissions from jet engines operated at simulated high-altitude supersonic flight conditions
A75-23963
- HYDROFOILS**
Study of materials and nonmetallic coatings for erosion and wear resistance
A75-23942
Effect of drag-reducing polymer injection on the lift and drag of a two-dimensional hydrofoil
[AD-A000262]
N75-17624
- HYDROGEN FUELS**
Study of active cooling for supersonic transports
[NASA-CR-132573]
N75-17336
- HYDROGENATION**
Jet fuel thermal stability improvements through fuel processing
[AD-A001623]
N75-17531
- HYPERBOLIC NAVIGATION**
Aids to air navigation
A75-23349
- HYPERSONIC AIRCRAFT**
Evaluation of routing and scheduling considerations for possible future commercial hypersonic transport aircraft
[NASA-CR-132632]
N75-18193
- HYPERSONIC BOUNDARY LAYER**
Hypersonic viscous slip flow over an insulated flat plate with real gas effects
A75-23205
- HYPERSONIC NOZZLES**
Low Reynolds number hypersonic nozzle flows
A75-24270
- HYPERSONIC SPEED**
Aerodynamic testing technique for twin fuselage models at hypersonic speeds
[NASA-TN-X-3196]
N75-18187
- ICE FORMATION**
Ice simulation: A 2-dimensional wind tunnel investigation of a NACA 652A215 wing section with single slotted flap. Part 2: Configurations typical for transport airplanes
[FFA-TN-AU-995-PT-2]
N75-17309
- ILYUSHIN AIRCRAFT**
The Il-18 aircraft /2nd enlarged and revised edition/ --- Russian book
A75-23421
- IMPACT DAMAGE**
Foreign object impact damage to composites; Proceedings of the Symposium, Philadelphia, Pa., September 20, 1973
A75-25229
Comparisons of the ballistic impact response of metals and composites for military aircraft applications
A75-25230
Impact response of graphite-epoxy flat laminates using projectiles that simulate aircraft engine encounters
A75-25232
Studies on the impact structural damage of composite blades
A75-25240
- IMPACT TESTS**
Experimentally verified analytical techniques for predicting vehicle crash response
[AIAA PAPER 75-273]
A75-25006
- IMPACT TOLERANCES**
Landing impact studies of a 0.3-scale model air cushion landing system for a Navy fighter airplane
[NASA-TN-D-7875]
N75-17342
- INCOMPRESSIBLE FLOW**
The structure and dynamics of vortex filaments --- in aircraft wakes
A75-24481
- INCOMPRESSIBLE FLUIDS**
Experimental study of the unsteady flow through a turbomachine stage
A75-23947
- INERT ATMOSPHERE**
Catalytic reactor for inerting of aircraft fuel tanks
[AD-A000939]
N75-18228
- INERTIAL NAVIGATION**
Laser gyro reaction time investigation program
[AD-A001646]
N75-17332
AN/ASN-90 systems improvement program --- for analysis of operational performance and operational maintenance
[AD-A001647]
N75-17333
- INFLATABLE STRUCTURES**
Long fluid filled bags suspended by line forces --- for airship design
A75-25988
- INFORMATION DISSEMINATION**
Methods of inspecting and preventing work defects during maintenance --- of aircraft
A75-23049
- INFORMATION FLOW**
The defect recording system and defect statistics for aircraft technology used by the CSA
A75-23047
- INFRARED SCANNERS**
Problems in the integration of infrared line scanners in high-performance aircraft
[DGLR PAPER 74-94]
A75-24143
- INLET FLOW**
Measurements of static inlet turbulence --- for turbofan engines
[AIAA PAPER 75-467]
A75-25743
- INSTRUMENT ERRORS**
Analysis of frequency error of airplane descent rate measured by a laser
A75-23797
Monte Carlo analysis of inaccuracies in estimated aircraft parameters caused by unmodeled flight instrumentation errors
[NASA-TN-D-7712]
N75-17368
- INSTRUMENT FLIGHT RULES**
Pilot control/display factors for helicopters /PIFAX-H/
A75-25070

INSTRUMENT LANDING SYSTEMS

Helicopter TERPS validation study, phase 1
[AD-A000423] N75-17347

INSULATED STRUCTURES

Hypersonic viscous slip flow over an insulated
flat plate with real gas effects A75-23205

INTEGRAL EQUATIONS

The determination of the subsonic flow of a
Chaplygin gas around a circular profile in the
presence of circulation A75-24061
Review of integral-equation techniques for solving
potential-flow problems with emphasis on the
surface-source method A75-25120

INTERNAL COMBUSTION ENGINES

Technology for reducing aircraft engine pollution
[NASA-TM-X-71670] N75-18237

INTERNAL COMPRESSION INLETS

Measurement of the internal performance of a
rectangular air intake mounted on a fuselage at
Mach numbers from 1.6 to 2, part 4
[ARC-CP-1291] N75-17305
Design of a very-low-bleed Mach 2.5
mixed-compression inlet with 45 percent internal
contraction [NASA-TM-X-3135] N75-17363

INTERNATIONAL COOPERATION

The technology of the aircraft MRCA and its systems
[DGLR PAPER 74-63] A75-24129

INTERNATIONAL LAW

The institutionalization and the general problems
of air traffic A75-23348

INVISCID FLOW

Application of a variational method in plane
compressible flow calculation --- steady
inviscid plane subsonic flow past an airfoil
[ARC-CP-1284] N75-17303

ITERATIVE SOLUTION

An iterative improvement for finite element analysis
A75-25212

J

J-58 ENGINE

Emission calibration of a J-58 afterburning
turbojet engine at simulated supersonic,
stratospheric flight conditions A75-23964

JET AIRCRAFT

Civil aircraft airworthiness data recording
programme. Uneven runways encountered by
subsonic jet transport aircraft during scheduled
airline operations [ARC-CP-1287] N75-17383

JET AIRCRAFT NOISE

Recent advances in exhaust systems for jet noise
suppression of high speed aircraft [AIAA PAPER 75-333] A75-25016
Turbine noise generation, reduction and prediction
[AIAA PAPER 75-449] A75-25731
Jet noise source location by cross-correlation of
far field microphone signals [AIAA PAPER 75-456] A75-25737
Measurement and prediction of jet noise in flight
[AIAA PAPER 75-461] A75-25738
Effect of forward motion on fan noise [AIAA PAPER 75-464] A75-25740
Model and full scale test results relating to fan
noise in-flight effects [AIAA PAPER 75-465] A75-25741
Experimental investigation of the aeroacoustic
characteristics of model slot nozzles with
straight flaps [AIAA PAPER 75-471] A75-25746
Acoustic characteristics of a large upper-surface
blown configuration with turbofan engines
[AIAA PAPER 75-473] A75-25748
The near field sound pressures of a choked jet
when oscillating in the spinning mode [AIAA PAPER 75-479] A75-25752
Diagnostic calculations of airframe-radiated noise
[AIAA PAPER 75-485] A75-25755
Minimization of jet and core noise of a turbojet
engine by swirling the exhaust flow [AIAA PAPER 75-503] A75-25769

Sparse matrix techniques applied to modal analysis
of multi-section duct liners [AIAA PAPER 75-514] A75-25780

An experimental investigation of the core engine
noise of a turbofan engine [AIAA PAPER 75-526] A75-25790

Review of theory and methods for turbine noise
prediction [AIAA PAPER 75-540] A75-25802

FAA JT3D quiet nacelle retrofit feasibility
program. Volume 4: Compatibility analysis and
design study for DC-8 aircraft [AD-783187] N75-17357

Engineering simulation development and evaluation
of the two-segment noise abatement approach
conducted in the B-727-222 flight simulator
[NASA-CR-137594] N75-18195

JET ENGINE FUELS

Laboratory evaluation of the stability of
high-purity jet fuels of the T-8 type and of the
effectiveness of antioxidants A75-24274

Future long-range transports: Prospects for
improved fuel efficiency [NASA-TM-X-72659] N75-17339

JET ENGINES

Propagation of sound in elliptic ducts A75-22791

Automatic Test System Jet Engine Accessories A75-23649

Near field noise prediction for a linear array of
turbojet engines [AD-A001329] N75-18976

JET EXHAUST

Measurements of supersonic jet aircraft wakes in
the stratosphere A75-23962

Hydrocarbon emissions from jet engines operated at
simulated high-altitude supersonic flight
conditions A75-23963

Emission calibration of a J-58 afterburning
turbojet engine at simulated supersonic,
stratospheric flight conditions A75-23964

Stratospheric pollution - Aircraft engine
emissions in the region above the tropopause as
a function of aircraft altitude and tropopause
height A75-23965

Recent advances in exhaust systems for jet noise
suppression of high speed aircraft [AIAA PAPER 75-333] A75-25016

Minimization of jet and core noise of a turbojet
engine by swirling the exhaust flow [AIAA PAPER 75-503] A75-25769

Cross-correlation of noise produced inside a hot
turbojet exhaust with and without suppression
using a new, hot probe [AIAA PAPER 75-505] A75-25771

JET FLAPS

Theoretical and experimental study on the ejector
augmented jet flap [NASA-CR-136749] N75-17296

Low speed wind tunnel test of jet flaps and
floating wingtip ailerons on a fighter wing
[AD-A000809] N75-17318

Application of the equivalent mechanical flap
concept to jet flapped wing-body combinations
[AD-A000431] N75-17346

JET FLOW

Tests of a theoretical model of jet noise ---
based on Lighthill-Bibner theory [AIAA PAPER 75-436] A75-25723

New evidence of subsonic jet noise mechanisms
[AIAA PAPER 75-437] A75-25724

Outdoor jet noise facility, a unique approach
[AIAA PAPER 75-530] A75-25792

A model for the vortex pair associated with a jet
in a cross flow [NASA-CR-136756] N75-17611

JET IMPINGEMENT

Fluctuating pressures on aircraft wing and flap
surfaces associated with powered-lift systems
[AIAA PAPER 75-472] A75-25747

JET MIXING FLOW

Measurement and prediction of jet noise in flight
[AIAA PAPER 75-461] A75-25738

JOURNAL BEARINGS

Diagonalization of the bearing matrix - A systematic method for the analysis of rotor-bearing dynamics

A75-23614

The steady state and dynamic behaviour of the turbo-bearing

A75-23615

JP-4 JET FUEL

Jet fuel thermal stability improvements through fuel processing

N75-17531

JP-5 JET FUEL

Prevaporization and premixing to obtain low oxides of nitrogen in gas turbine combustors

N75-17362

L

LAMINAR FLOW

Experimental determination of the separation point of flow around a circular cylinder

A75-22868

LAMINATES

Evaluation of stiffness coefficients for fiber-reinforced laminated composites

A75-23667

Impact response of graphite-epoxy flat laminates using projectiles that simulate aircraft engine encounters

A75-25232

LANDING AIDS

An investigation of errors and data processing techniques for an RP multilateration system --- position and velocity measurements of vertical takeoff aircraft during landing

N75-17327

LANDING SIMULATION

Forward velocity effects on under-the-wing externally blown flap noise

A75-25750

LANDING SITES

An investigation of rooftop STOL port aerodynamics

N75-17381

LANDING SPEED

Analysis of frequency error of airplane descent rate measured by a laser

A75-23797

LASER RANGE FINDERS

Analysis of frequency error of airplane descent rate measured by a laser

A75-23797

LASERS

Design analysis of helicopter automatic and semiautomatic airborne precision pointing and tracking systems

N75-18229

LATERAL CONTROL

Problems and implementation possibilities of a direct side force control in the case of fighters

A75-24140

LAW (JURISPRUDENCE)

Methods for the determination of noise protection areas in accordance with the law for protection against aircraft noise

A75-24150

LEADING EDGES

Ice simulation: A 2-dimensional wind tunnel investigation of a NACA 652A215 wing section with single slotted flap. Part 2: Configurations typical for transport airplanes

N75-17309

Preliminary experiments on film cooling of turbine blades with injection near the leading edge. 1: Injection through holes located near the leading edge

N75-17359

LEAST SQUARES METHOD

Approximate solution of integral equations with a singular operator --- for wing motion

A75-24835

LIAPUNOV FUNCTIONS

Stability theory and its applications to structural mechanics --- Book

A75-25181

LIFT

The subsonic-supersonic analogy --- for flow around wing profiles

A75-25459

A practical concept for powered or tethered weight-lifting LTA vehicles

A75-26022

LIFT AUGMENTATION

Theoretical and experimental study on the ejector augmented jet flap

N75-17296

LIFT DEVICES

The viscous flow around a two dimensional high lift wing. Analysis of boundary layer measurements

N75-17310

LIFT DRAG RATIO

Comparative airship economics --- design and freight transport factors

A75-25973

LIFT FANS

Acoustic test results from a 36 inch (0.914m) statorless lift fan with serrated and unserrated rotor blades

N75-18242

LIFTING BODIES

Separation of turbulent boundary layer on a lifting cylinder

A75-23223

A finite element approach to the aeroelastic analysis of lifting surface type structures

A75-24918

The basic characteristics of hybrid aircraft

A75-26005

A semibuoyant vehicle for general transportation missions

A75-26006

The Dynairship --- deltoid aerobody combining buoyant and dynamic lift

A75-26007

LIGHT AIRCRAFT

Noise reduction studies for the Cessna model 337 (0-2) airplane

N75-18231

Ground noise measurements during static and flyby operations of the Cessna 02-T turbine powered airplane

N75-18234

LIGHTING EQUIPMENT

US Army Human Engineering Laboratory helicopter cockpit lighting study. Phase 1: An evaluation of current and potential instrument panel lighting techniques for use in Army helicopters

N75-17351

LIGHTNING

The effects of lightning on digital flight control systems

N75-18249

LINEAR SYSTEMS

A controller of variable structure for the reduction of the complexity of flight control systems

A75-24136

LININGS

Sparse matrix techniques applied to modal analysis of multi-section duct liners

A75-25780

LOAD DISTRIBUTION (FORCES)

Stabilization of externally slung helicopter loads

N75-18224

LOAD TESTING MACHINES

A new biaxial tensile testing machine

A75-24068

LOADING OPERATIONS

The Airfloat HL project --- heavy lift airship

A75-26004

LOGISTICS MANAGEMENT

Airship logistics - The LTA vehicle, a total cargo system

A75-26015

'LOTS' of LTA applications --- Logistics Over The Shore operations

A75-26027

LOGISTICS OVER THE SHORE (LOTS) CARRIER

'LOTS' of LTA applications --- Logistics Over The Shore operations

A75-26027

LONGITUDINAL CONTROL

Effects of nozzle interfairing modifications on longitudinal aerodynamic characteristics of a twin jet, variable wing sweep fighter model

N75-18180

Report on program to improve MIL-F-83300 ---
simulation of short takeoff aircraft
longitudinal characteristics
[AD-A001598] A75-18226

LOBAN
Aids to air navigation A75-23349

LOW ASPECT RATIO WINGS
Substantiation of discrete-continuum
low-aspect-ratio wing structural analysis scheme
A75-23798

LOW COST
Aeroflight communications and RF nav aids --- for
space shuttle orbiters A75-23912

LOW DENSITY FLOW
Static pressure on sharp and blunt cones in
conical and parallel low-density flow
[AD-A001632] A75-18191

LOW PRESSURE
Pressure increase in blade channels of axial-flow
compressors at low gas pressures A75-23099

LOWER ATMOSPHERE
Propagation of aircraft noise over long distances
through the lower atmosphere
[AIAA PAPER 75-542] A75-25804

M

MAN MACHINE SYSTEMS
Manual control system design using a dual
suboptimal control model A75-24839

MANAGEMENT METHODS
Warranties as a life-cycle-cost management tool
--- for military aircraft equipment A75-26099

MANAGEMENT PLANNING
Maintenance overhauls performed according to an
overhaul schedule --- programming aircraft repairs
A75-23044

Methods of production planning in aircraft
maintenance A75-23045

Aerospace technology - Planning methodology and
defense-technological objectives
[DGLR PAPER 74-67] A75-24130

Simulation - An aid to aircraft maintenance
management A75-24756

MANEUVERABILITY
Some aspects of Hybrid-Zeppelins --- with slender
delta wing A75-26008

MANUAL CONTROL
Manual control system design using a dual
suboptimal control model A75-24839

MARITIME SATELLITES
Aero-marine communications by satellite A75-24100

MARKET RESEARCH
An approach to market analysis for lighter than
air transportation of freight A75-25979

Market assessment in connection with lighter than
air --- airships A75-25980

MASS FLOW RATE
Nonintrusive ultrasonic measurement of flow
velocity and mass flow rate A75-22880

MATERIALS HANDLING
The transport of nuclear power plant components
A75-26016

MATERIALS SCIENCE
Study of materials and nonmetallic coatings for
erosion and wear resistance A75-23942

MATHEMATICAL MODELS
Modern control - Modeling and application in real
aircraft flight control system design A75-24758

Tests of a theoretical model of jet noise ---
based on Lighthill-Ribner theory
[AIAA PAPER 75-436] A75-25723

Experimental study of a two pressure stage air
cushion [NT-36] A75-18174

MATRIX METHODS
Matrix difference equation analysis of vibrating
periodic structures --- aircraft engine parts
A75-23201

Sparse matrix techniques applied to modal analysis
of multi-section duct liners
[AIAA PAPER 75-514] A75-25780

MATRIX THEORY
Diagonalization of the bearing matrix - A
systematic method for the analysis of
rotor-bearing dynamics A75-23614

MEASURING INSTRUMENTS
Characteristics of air bearings with small inlet
holes for a precision coordinate measuring device
A75-25715

MECHANICAL PROPERTIES
Investigation of the structure and properties of
niobium in vacuum and in high-velocity air streams
A75-23009

The use of fiber-reinforced materials for
compressor blades
[DGLR PAPER 74-122] A75-24159

MEMBRANE STRUCTURES
Finite element flutter analysis of multi-web wing
structures A75-22795

Long fluid filled bags suspended by line forces
--- for airship design A75-25988

METAL JOINTS
A leak-free mechanical tube joint A75-23240

Load distribution on threads of titanium tension
nuts and steel bolts
[ASME PAPER 74-DE-N] A75-23638

METAL MATRIX COMPOSITES
The use of fiber-reinforced materials for
compressor blades
[DGLR PAPER 74-122] A75-24159

Comparisons of the ballistic impact response of
metals and composites for military aircraft
applications A75-25230

Studies on the impact structural damage of
composite blades A75-25240

METAL PARTICLES
Supersonic flow of a lightly dust-laden gas past a
wedge A75-23298

METEOROLOGICAL FLIGHT
Results of intercomparison flights between the
NAE-T-33 and the NCAR Buffalo atmospheric
Research aircraft
[AD-A001436] A75-17352

MICROPHONES
Jet noise source location by cross-correlation of
far field microphone signals
[AIAA PAPER 75-456] A75-25737

MICROSTRUCTURE
Investigation of the structure and properties of
niobium in vacuum and in high-velocity air streams
A75-23009

MILITARY AIRCRAFT
Navy Aircrew Escape Propulsion System Program
A75-25054

Comparisons of the ballistic impact response of
metals and composites for military aircraft
applications A75-25230

An LTA flight research vehicle --- airship
development A75-26003

Military applications of rigid airships --- aerial
surveillance and cargo transport A75-26013

US Army Human Engineering Laboratory helicopter
cockpit lighting study. Phase I: An evaluation
of current and potential instrument panel
lighting techniques for use in Army helicopters
[AD-A001527] A75-17351

A procedure for the design of multifunction
switching controls
[AD-A000532] A75-17354

SUBJECT INDEX

NOISE MEASUREMENT

Statistical review of counting accelerometer data for Navy and Marine fleet aircraft
[AD-A00092] N75-17355

MILITARY HELICOPTERS

US Army Human Engineering Laboratory helicopter cockpit lighting study. Phase 1: An evaluation of current and potential instrument panel lighting techniques for use in Army helicopters
[AD-A001527] N75-17351

Analysis and design of a multi-axis vibration isolator for missile pods mounted on Army helicopters
[AD-A001459] N75-18225

Design analysis of helicopter automatic and semiautomatic airborne precision pointing and tracking systems
[AD-A000834] N75-18229

MILITARY OPERATIONS

Military applications of rigid airships --- aerial surveillance and cargo transport
A75-26013

'LOTS' of LTA applications --- Logistics Over The Shore operations
A75-26027

MILITARY TECHNOLOGY

Aerospace technology - Planning methodology and defense-technological objectives
[DGLR PAPER 74-67] A75-24130

Warranties as a life-cycle-cost management tool --- for military aircraft equipment
A75-26099

MILLIMETER WAVES

Millimeter radar for low angle tracking
A75-26038

MOBILE LOUNGES

Mobile lounge or fixed gate --- airport terminal design
A75-25343

MODAL RESPONSE

Sparse matrix techniques applied to modal analysis of multi-section duct liners
[AIAA PAPER 75-514] A75-25780

MOMENT DISTRIBUTION

Airship stresses due to vertical velocity gradients and atmospheric turbulence
A75-25984

MONOCOQUE STRUCTURES

Experimentally verified analytical techniques for predicting vehicle crash response
[AIAA PAPER 75-273] A75-25006

MONOPULSE RADAR

High range-resolution monopulse tracking radar and applications --- for target recognition
A75-26041

DABS - Projected performance and experimental results --- Discrete Address Beacon System for ATC
A75-26061

Monte CARLO METHOD

Monte Carlo analysis of inaccuracies in estimated aircraft parameters caused by unmodeled flight instrumentation errors
[NASA-TN-D-7712] N75-17368

MOORING

Mooring and ground handling rigid airships
A75-25996

A new concept for airship mooring and ground handling
A75-25997

Aerocrane - A hybrid LTA aircraft for aerial crane applications
A75-26019

N

NACELLES

FAA JT3D quiet nacelle retrofit feasibility program. Volume 3: Lower goal flight testing, economic analyses and summary
[AD-787610] N75-17334

NASA PROGRAMS

A flight research program to develop airborne systems for improved terminal area operations
A75-24803

NASA general aviation technology programs
[AIAA PAPER 75-290] A75-25007

NASA's role in aeronautics
A75-25713

Development of a new computer system for aircraft noise prediction
[AIAA PAPER 75-536] A75-25798

NATURAL GAS

The aerospace developments concept --- airship design for natural gas transport
A75-26000

Method for transporting impellent gases
A75-26001

NAVIGATION AIDS

Aids to air navigation
A75-23349

Aeroflight communications and RF nav aids --- for space shuttle orbiters
A75-23912

SLAR, its principles of operation and requirements regarding the positional stability of carrier platforms
A75-25697

NAVIGATION INSTRUMENTS

Theory of astronomical correction --- Russian book on celestial navigation of flight vehicles
A75-23395

NEAR FIELDS

The near field sound pressures of a choked jet when oscillating in the spinning mode
[AIAA PAPER 75-479] A75-25752

NEWTONIAN FLUIDS

Generalized aerodynamic noise equation
A75-24418

NICKEL ALLOYS

NASA vane alloy boasts high-temperature strength
A75-24003

NIOBIUM ALLOYS

Investigation of the structure and properties of niobium in vacuum and in high-velocity air streams
A75-23009

NITROGEN OXIDES

First results of a general circulation model applied to the SST-NOx problem --- ozone decomposition
A75-23982

Prevaporization and premixing to obtain low oxides of nitrogen in gas turbine combustors
[NASA-CR-2495] N75-17362

NOISE (SOUND)

Near field noise prediction for a linear array of turbojet engines
[AD-A001329] N75-18976

NOISE GENERATORS

Noncompact source effect on the prediction of tone noise from a fan rotor
[AIAA PAPER 75-446] A75-25730

The noise behaviour of aero engine turbine tones
[AIAA PAPER 75-466] A75-25742

A study of subsonic fan noise sources
[AIAA PAPER 75-468] A75-25744

Diagnostic calculations of airframe-radiated noise
[AIAA PAPER 75-485] A75-25755

A preliminary investigation of remotely piloted vehicles for airframe noise research
[AIAA PAPER 75-512] A75-25778

Generalized wave envelope analysis of sound propagation in ducts with stepped noise source profiles and variable axial impedance
[AIAA PAPER 75-518] A75-25784

The convergence of theory and experiment in direct combustion generated noise
[AIAA PAPER 75-522] A75-25786

Combustion intensity and distribution relation to noise generation
[AIAA PAPER 75-524] A75-25788

Review of theory and methods for turbine noise prediction
[AIAA PAPER 75-540] A75-25802

Review of theory and methods for combustion noise prediction
[AIAA PAPER 75-541] A75-25803

NOISE INTENSITY

Experiments on supersonic jet noise
[AIAA PAPER 75-478] A75-25751

NOISE MEASUREMENT

Discrete frequency rotor noise --- from helicopters
[AIAA PAPER 75-451] A75-25733

Thickness noise of helicopter rotors at high tip speeds
[AIAA PAPER 75-453] A75-25735

Measurement and prediction of jet noise in flight
[AIAA PAPER 75-461] A75-25738

- Simulation of flight effects on aero engine fan noise
[AIAA PAPER 75-463] A75-25739
- Measurements of static inlet turbulence --- for turbofan engines
[AIAA PAPER 75-467] A75-25743
- Experimental investigation of the aeroacoustic characteristics of model slot nozzles with straight flaps
[AIAA PAPER 75-471] A75-25746
- Ambient and induced pressure fluctuations in supersonic jet flows --- acoustic tracing of noise source
[AIAA PAPER 75-482] A75-25754
- Aircraft far-field aerodynamic noise - Its measurement and prediction
[AIAA PAPER 75-486] A75-25756
- Measurements of discrete vortex noise in a closed-throat wind tunnel
[AIAA PAPER 75-488] A75-25758
- The effects of forward speed on a number of turbojet exhaust silencers
[AIAA PAPER 75-506] A75-25772
- Airframe noise measurements on a transport model in a quiet flow facility
[AIAA PAPER 75-509] A75-25775
- Measurements and analysis of aircraft airframe noise
[AIAA PAPER 75-510] A75-25776
- An experimental study of airframe self-noise
[AIAA PAPER 75-511] A75-25777
- Outdoor jet noise facility, a unique approach
[AIAA PAPER 75-530] A75-25792
- NOISE POLLUTION**
- Airport noise abatement - How effective can it be
A75-23125
- Aircraft noise in a high-rise city
A75-24000
- The design of flight control devices with the aid of modern system theory
[DGLR PAPER 74-77] A75-24134
- Methods for the determination of noise protection areas in accordance with the law for protection against aircraft noise
[DGLR PAPER 74-110] A75-24150
- A contribution to the problem of noise produced at the takeoff and landing of VTOL aircraft
[DGLR PAPER 74-116] A75-24153
- Measurements and analysis of aircraft airframe noise
[AIAA PAPER 75-510] A75-25776
- Aircraft flyover noise measurements
[AIAA PAPER 75-537] A75-25799
- Methods for the prediction of airframe aerodynamic noise
[AIAA PAPER 75-539] A75-25801
- NOISE PROPAGATION**
- New evidence of subsonic jet noise mechanisms
[AIAA PAPER 75-437] A75-25724
- The noise behaviour of aero engine turbine tones
[AIAA PAPER 75-466] A75-25742
- Noise radiation from turbulent flows over compliant surfaces
[AIAA PAPER 75-507] A75-25773
- Computational methods for acoustic radiation from circular ducts
[AIAA PAPER 75-516] A75-25782
- Review of theory and methods for the prediction of ground effects on aircraft noise propagation
[AIAA PAPER 75-538] A75-25800
- Review of theory and methods for turbine noise prediction
[AIAA PAPER 75-540] A75-25802
- Propagation of aircraft noise over long distances through the lower atmosphere
[AIAA PAPER 75-542] A75-25804
- Broadband noise generated by turbulent inflow to rotor or stator blades in an annular duct
[NASA-CR-2503] A75-17361
- NOISE REDUCTION**
- Propagation of sound in elliptic ducts
A75-22791
- Airport noise abatement - How effective can it be
A75-23125
- Noise legislation and regulations
A75-23436
- Recent advances in the technology of aircraft noise control
[AIAA PAPER 75-317] A75-25014
- Recent advances in exhaust systems for jet noise suppression of high speed aircraft
[AIAA PAPER 75-333] A75-25016
- Turbine noise generation, reduction and prediction
[AIAA PAPER 75-449] A75-25731
- Measurement and prediction of jet noise in flight
[AIAA PAPER 75-461] A75-25738
- Effect of forward motion on fan noise
[AIAA PAPER 75-464] A75-25740
- Noise shielding effects for engine-over-wing installations
[AIAA PAPER 75-474] A75-25749
- Influence of grazing flow on duct wall normal impedances --- for noise reduction
[AIAA PAPER 75-494] A75-25763
- Minimization of jet and core noise of a turbojet engine by swirling the exhaust flow
[AIAA PAPER 75-503] A75-25769
- An experimental investigation of noise-shielding effects for a delta-winged aircraft in flight, wind tunnel and anechoic room
[AIAA PAPER 75-513] A75-25779
- Sparse matrix techniques applied to modal analysis of multi-section duct liners
[AIAA PAPER 75-514] A75-25780
- An experimental investigation of the core engine noise of a turbofan engine
[AIAA PAPER 75-526] A75-25790
- FAA JT3D quiet nacelle retrofit feasibility program. Volume 3: Lower goal flight testing, economic analyses and summary
[AD-787610] A75-17334
- Noise reduction studies for the U-10 airplane
[NASA-TM-X-72640] A75-17360
- Static and wind tunnel model tests for the development of externally blown flap noise reduction techniques
[NASA-CR-134675] A75-18177
- Engineering simulation development and evaluation of the two-segment noise abatement approach conducted in the B-727-222 flight simulator
[NASA-CR-137594] A75-18195
- Noise reduction studies for the Cessna model 337 (O-2) airplane
[NASA-TM-X-72641] A75-18231
- Noise reduction studies for the OV-1 airplane
[NASA-TM-X-72639] A75-18232
- Noise characteristics of the O-1 airplane and some approaches to noise reduction
[NASA-TM-X-72638] A75-18233
- Ground noise measurements during static and flyby operations of the Cessna 02-T turbine powered airplane
[NASA-TM-X-72642] A75-18234
- Noise reduction studies of several aircraft to reduce their aural detection distances
[NASA-TM-X-72644] A75-18235
- A noise study of the A-6 airplane and techniques for reducing its aural detection distance
[NASA-TM-X-72643] A75-18236
- NOISE SPECTRA**
- Tests of a theoretical model of jet noise --- based on Lighthill-Ribner theory
[AIAA PAPER 75-436] A75-25723
- Scrubbing noise of externally blown flaps
[AIAA PAPER 75-469] A75-25745
- The convergence of theory and experiment in direct combustion generated noise
[AIAA PAPER 75-522] A75-25786
- An experimental investigation of the core engine noise of a turbofan engine
[AIAA PAPER 75-526] A75-25790
- Aircraft flyover noise measurements
[AIAA PAPER 75-537] A75-25799
- Review of theory and methods for combustion noise prediction
[AIAA PAPER 75-541] A75-25803
- NONDESTRUCTIVE TESTS**
- Practical applications of acoustic emission --- for pressure vessels, aircraft structures and solid propellants
A75-24461
- NONLINEAR FILTERS**
- Design of a guided flight vehicle according to viewpoints of probability theory, taking into account perturbation and control parameters
[DGLR PAPER 74-80] A75-24137

SUBJECT INDEX

PANEL FLUTTER

NONUNIFORM FLOW

Averaging of nonuniform flow in turbomachine flow traverses
A75-23821

NOSE CONES

Static pressure on sharp and blunt cones in conical and parallel low-density flow
[AD-A001632] N75-18191

NOTCH TESTS

Fracture mechanics' impact on specifications and supply --- test methods for aircraft aluminum alloys
A75-24004

NOZZLE DESIGN

Optimization of wind tunnel nozzles for the subsonic range
A75-24271

Recent advances in exhaust systems for jet noise suppression of high speed aircraft
[AIAA PAPER 75-333] A75-25016

The effects of forward speed on a number of turbojet exhaust silencers
[AIAA PAPER 75-506] A75-25772

NOZZLE EFFICIENCY

Study of annular nozzle cascades with different 'reverse' vane twist
A75-23818

NOZZLE FLOW

Low Reynolds number hypersonic nozzle flows
A75-24270

Simulation of hypersonic scramjet exhaust --- pressure distribution on afterbody/nozzle sections of vehicle
[NASA-CR-2494] N75-17344

Effects of nozzle interfairing modifications on longitudinal aerodynamic characteristics of a twin jet, variable wing sweep fighter model
[NASA-TN-D-7817] N75-18180

NUCLEAR POWER PLANTS

The transport of nuclear power plant components
A75-26016

NUMERICAL ANALYSIS

Calculation by the singularity method of the characteristics of a cascade in compressible flow without knocking up to the supercritical speed
A75-23988

Contribution to the study of supercritical profile flow
[DGLR PAPER 74-99] A75-24146

Low Reynolds number hypersonic nozzle flows
A75-24270

Computational methods for acoustic radiation from circular ducts
[AIAA PAPER 75-516] A75-25782

On the natural vibration of plate-beam combination structures, 4
[NAL-TR-363] N75-17707

NUMERICAL CONTROL

Control and program technology for the implementation of digital flight control systems
[DGLR PAPER 74-81] A75-24138

NUMERICAL FLOW VISUALIZATION

Numerical solutions for supersonic corner flow
A75-23295

NUMERICAL INTEGRATION

Calculation of turbulent shear stress in supersonic boundary-layer flows
A75-23209

NUTS (PASTENERS)

Load distribution on threads of titanium tension nuts and steel bolts
[ASME PAPER 74-DE-N] A75-23638

ONBOARD EQUIPMENT

SLAR, its principles of operation and requirements regarding the positional stability of carrier platforms
A75-25697

OPERATIONAL PROBLEMS

The institutionalization and the general problems of air traffic
A75-23348

Performance survey of the air traffic control radar beacon system
A75-23459

Operational considerations for the airship in short-haul transportation
A75-25993

OPERATIONS RESEARCH

Decision-making model for ATC system improvement
A75-24754

AN/ASN-90 systems improvement program --- for analysis of operational performance and operational maintenance
[AD-A001647] N75-17333

OPERATOR PERFORMANCE

Manual control system design using a dual suboptimal control model
A75-24839

OPTICAL COMMUNICATION

Data transmission by optical fibers aboard aircraft
A75-23855

OPTICAL EQUIPMENT

Design analysis of helicopter automatic and semiautomatic airborne precision pointing and tracking systems
[AD-A005834] N75-18229

OPTICAL PROPERTIES

Proposed windshield for B-1 aircraft: An optical evaluation
[AD-A001078] N75-17350

OPTIMAL CONTROL

A controller of variable structure for the reduction of the complexity of flight control systems
[DGLR PAPER 74-79] A75-24136

Design of a guided flight vehicle according to viewpoints of probability theory, taking into account perturbation and control parameters
[DGLR PAPER 74-80] A75-24137

Modern control - Modeling and application in real aircraft flight control system design
A75-24758

Manual control system design using a dual suboptimal control model
A75-24839

Ejection seat steering and control
A75-25067

Multilevel control optimization using subsystem relative performance index sensitivity
A75-25098

OPTIMIZATION

Methods of production planning in aircraft maintenance
A75-23045

Optimization of wind tunnel nozzles for the subsonic range
A75-24271

System design of a rudder coordination system --- optimization computer program
[NASA-CR-142245] N75-18223

ORIFICE FLOW

Influence of grazing flow on duct wall normal impedances --- for noise reduction
[AIAA PAPER 75-494] A75-25763

OSCILLATING FLOW

Trailing edge noise --- generated by oscillatory flow on flat plate
[AIAA PAPER 75-489] A75-25759

OV-1 AIRCRAFT

Noise reduction studies for the OV-1 airplane
[NASA-TN-X-72639] N75-18232

OXYGEN SUPPLY EQUIPMENT

Factors in the design of solid oxygen systems for aircraft
A75-25061

OZONE

Possible climatic effects of supersonic transports
A75-23973

First results of a general circulation model applied to the SST-NOx problem --- ozone decomposition
A75-23982

P

PANEL FLUTTER

Fundamental frequency of a square panel with multiple point supports on edges
A75-22798

A finite element approach to the aeroelastic analysis of lifting surface type structures
A75-24918

PASSENGER AIRCRAFT

- Exploitation of air conditioning systems for passenger aircraft --- Russian book A75-23375
- Corporate/executive aircraft passenger safety - An educational approach A75-25874
- PAYLOADS**
- Airship logistics - The LTA vehicle, a total cargo system A75-26015
- PCM TELEMETRY**
- The future of real time telemetry systems --- for computerized testing of aerospace vehicles A75-23889
- An integrated PCM data system for full scale aeronautics testing --- common data bases for user requirements A75-23902
- PERFORMANCE PREDICTION**
- Experimentally verified analytical techniques for predicting vehicle crash response [AIAA PAPER 75-273] A75-25006
- Aircraft far-field aerodynamic noise - Its measurement and prediction [AIAA PAPER 75-486] A75-25756
- Boundary layer control for airships A75-25983
- Evaluation of a Sperry Lidar Ceilometer [AD-777820] N75-17653
- PERFORMANCE TESTS**
- F-15 update report A75-24806
- Test bed for the upgraded third generation Air Traffic Control System A75-26064
- Measurement of the internal performance of a rectangular air intake mounted on a fuselage at Mach numbers from 1.6 to 2, part 4 [ARC-CP-1291] N75-17305
- PERTURBATION THEORY**
- Diagonalization of the bearing matrix - A systematic method for the analysis of rotor-bearing dynamics A75-23614
- Analytic construction of function for conformal transformation of exterior of circle onto exterior of arbitrary wing profile A75-23794
- PILOT ERROR**
- General aviation safety - Fact and fiction A75-25719
- PILOT PERFORMANCE**
- Manual control system design using a dual suboptimal control model A75-24839
- Pilot control/display factors for helicopters /PIPAH-/ A75-25070
- A laser-generated visual display and tracking task for a link GAT-1 flight trainer [AD-A001079] N75-17391
- Pilot preference and procedures at uncontrolled airports [NASA-TN-D-7928] N75-18169
- PIPELINES**
- Airships for transporting highly volatile commodities --- compared with ocean tankers and gas pipelines A75-26017
- PITCH (INCLINATION)**
- A state-variable design approach for a high-performance aerospace vehicle pitch orientation system with variable coefficients A75-23457
- Fly-by-wire delta-canard configurations save weight [SAME PAPER SWR 3] A75-24345
- PITCHING MOMENTS**
- The planar dynamics of airships A75-25986
- Comparison between dynamic stability boundaries for NPL 9615 and NACA 0012 aerofoils pitching about the quarter-chord [ARC-CP-1279] N75-17302
- PLANE WAVES**
- On the excess attenuation of sound in the atmosphere [NASA-TN-D-7823] N75-18030

PLASTIC AIRCRAFT STRUCTURES

- Effects of fatigue and dynamic recovery on rain erosion --- plastic coatings and composite materials tests A75-25189
- PLASTIC COATINGS**
- Study of materials and nonmetallic coatings for erosion and wear resistance A75-23942
- PLASTIC TAPES**
- R/C tape laying - Tomorrow's future today --- for helicopter rotor blade manufacturing [SHE PAPER MS74-729] A75-23441
- PLATE THEORY**
- Aeroelasticity of plates and shells --- Book A75-25180
- PLATES (STRUCTURAL MEMBERS)**
- On the natural vibration of plate-beam combination structures, 4 [NAL-TR-363] N75-17707
- POLLUTION CONTROL**
- Design of low-pollution burners A75-24945
- POLYETHYLENES**
- Effect of drag-reducing polymer injection on the lift and drag of a two-dimensional hydrofoil [AD-A000262] N75-17624
- POSITION ERRORS**
- Theory of astronomical correction --- Russian book on celestial navigation of flight vehicles A75-23395
- Millimeter radar for low angle tracking A75-26038
- POSITION INDICATORS**
- Characteristics of air bearings with small inlet holes for a precision coordinate measuring device A75-25715
- POTENTIAL FLOW**
- Analytic construction of function for conformal transformation of exterior of circle onto exterior of arbitrary wing profile A75-23794
- Review of integral-equation techniques for solving potential-flow problems with emphasis on the surface-source method A75-25120
- POWDER METALLURGY**
- Cost savings in the application of P/M titanium and P/M aluminum alloys A75-23412
- POWER EFFICIENCY**
- Thermodynamics of multistage air-cooled gas turbine A75-23817
- POWER SUPPLY CIRCUITS**
- VSCF starter generator --- variable speed constant frequency cycloconverter for aircraft applications A75-23594
- PREDICTION ANALYSIS TECHNIQUES**
- Engine failure prediction techniques A75-25274
- Turbine noise generation, reduction and prediction [AIAA PAPER 75-449] A75-25731
- Measurement and prediction of jet noise in flight [AIAA PAPER 75-461] A75-25738
- Development of a new computer system for aircraft noise prediction [AIAA PAPER 75-536] A75-25798
- Methods for the prediction of airframe aerodynamic noise [AIAA PAPER 75-539] A75-25801
- Review of theory and methods for turbine noise prediction [AIAA PAPER 75-540] A75-25802
- Review of theory and methods for combustion noise prediction [AIAA PAPER 75-541] A75-25803
- PRESSURE DISTRIBUTION**
- Measured three-dimensional effects in transonic airfoil testing A75-23222
- Unsteady flow through a turbomachine stage with free vortex shed A75-23945
- Noncompact source effect on the prediction of tone noise from a fan rotor [AIAA PAPER 75-446] A75-25730
- Scrubbing noise of externally blown flaps [AIAA PAPER 75-469] A75-25745

Transonic wind tunnel tests on two-dimensional aerofoil sections Part 1: Determination of pressure distribution and drag for an aerofoil of type NLR 13 in PFA wind tunnel S5 [PPA-TN-AU-725-PT-1] N75-17299

A prediction method for pressure distributions on compression surfaces of conical bodies at supersonic speeds --- delta wings, conical bodies, and two dimensional flow [ABC-CP-1295] N75-17307

Simulation of hypersonic scramjet exhaust --- pressure distribution on afterbody/nozzle sections of vehicle [NASA-CR-2494] N75-17344

Experimental study of a two pressure stage air cushion [NT-36] N75-18174

Static pressure on sharp and blunt cones in conical and parallel low-density flow [AD-A001632] N75-18191

PRESSURE OSCILLATIONS

Wake cutting by a cascade of cambered blades [AIAA PAPER 75-445] A75-25729

Fluctuating pressures on aircraft wing and flap surfaces associated with powered-lift systems [AIAA PAPER 75-472] A75-25747

Ambient and induced pressure fluctuations in supersonic jet flows --- acoustic tracing of noise source [AIAA PAPER 75-482] A75-25754

Effect of geometry on open cavity flow-induced pressure oscillations [AIAA PAPER 75-492] A75-25761

Noise radiation from turbulent flows over compliant surfaces [AIAA PAPER 75-507] A75-25773

Combustion intensity and distribution relation to noise generation [AIAA PAPER 75-524] A75-25788

PRESSURE SENSORS

Experimental determination of the separation point of flow around a circular cylinder A75-22868

Miniature probe for transonic flow direction measurements A75-23224

PRESSURE VESSELS

Practical applications of acoustic emission --- for pressure vessels, aircraft structures and solid propellants A75-24461

PRESSURIZED CABINS

Stress analysis of aircraft fuselages and pressurized cabins --- Russian book A75-23231

PROBABILITY THEORY

Design of a guided flight vehicle according to viewpoints of probability theory, taking into account perturbation and control parameters [DGLR PAPER 74-80] A75-24137

PROBLEM SOLVING

A curve fitting method for solving the flutter equation [NASA-CR-132629] N75-17341

PRODUCTION ENGINEERING

Aircraft switching devices: Fabrication technology and installation --- Russian book A75-23369

PRODUCTION MANAGEMENT

Methods of production planning in aircraft maintenance A75-23045

PROGRAMMING (SCHEDULING)

Maintenance overhauls performed according to an overhaul schedule --- programming aircraft repairs A75-23044

PROPELLER BLADES

Aerodynamics of the propellers of rapidly convertible VTOL aircraft A75-24942

PROPELLER DRIVE

Unmanned powered balloons A75-26020

PROPELLER EFFICIENCY

Noise of high speed rotors --- theory for propeller and helicopter configurations [AIAA PAPER 75-450] A75-25732

PROPELLER FANS

A study of subsonic fan noise sources [AIAA PAPER 75-468] A75-25744

PROPELLERS

V/STOL rotor and propeller noise - Its prediction and analysis of its aural characteristics [AIAA PAPER 75-452] A75-25734

PROPULSION

The NASA research program on propulsion for supersonic cruise aircraft [NASA-TN-X-71666] N75-18238

PROPULSION SYSTEM CONFIGURATIONS

Future long-range transports: Prospects for improved fuel efficiency [NASA-TN-X-72659] N75-17339

Design of a very-low-bleed Mach 2.5 mixed-compression inlet with 45 percent internal contraction [NASA-TN-X-3135] N75-17363

PROPULSION SYSTEM PERFORMANCE

Developmental programs for small expendable turbojets A75-24946

Floating vs flying - A propulsion energy comparison A75-25987

Unmanned powered balloons A75-26020

Preliminary study of advanced turbofans for low energy consumption [NASA-TN-X-71663] N75-18241

PROPULSIVE EFFICIENCY

'Ring vortex' energy losses during centrifugal fan operation in low output regimes A75-23806

Study of annular nozzle cascades with different 'reverse' vane twist A75-23818

Floating vs flying - A propulsion energy comparison A75-25987

PROTECTIVE COATINGS

Coatings protect superalloys in gas-turbine applications A75-24005

PULSE COMMUNICATION

Data transmission by optical fibers aboard aircraft A75-23855

Q

QUADRATIC EQUATIONS

Optimization of structures to satisfy a flutter velocity constraint by use of quadratic equation fitting [NASA-CR-132628] N75-17711

QUALITY CONTROL

Methods of inspecting and preventing work defects during maintenance --- of aircraft A75-23049

Reliability of airframes --- Russian book on quality control during planning, production and maintenance A75-23428

Simulation - An aid to aircraft maintenance management A75-24756

R

RADAR ANTENNAS

Laterally displaced ISLS antenna for tactical radar --- Interrogation Side Lobe Suppression A75-25926

RADAR BEACONS

Performance survey of the air traffic control radar beacon system A75-23459

Laterally displaced ISLS antenna for tactical radar --- Interrogation Side Lobe Suppression A75-25926

DABS - Projected performance and experimental results --- Discrete Address Beacon System for ATC A75-26061

Study of alternative beacon based surveillance and data link systems, volume 2 [AD-772136] N75-17325

RADAR EQUIPMENT

SUBJECT INDEX

RADAR EQUIPMENT

SLAR, its principles of operation and requirements regarding the positional stability of carrier platforms A75-25697

RADAR RANGE
High range-resolution monopulse tracking radar and applications --- for target recognition A75-26041

RADAR SCANNING
Results of the investigation regarding two three-dimensional low-level flight control systems [DGLR PAPER 74-83] A75-24139

RADAR SIGNATURES
Target identification by natural resonance estimation --- radar signatures A75-25878

RADAR TRACKING
Millimeter radar for low angle tracking A75-26038

RADIATION EFFECTS
The effects of lightning on digital flight control systems N75-18249

RADIO COMMUNICATION
ATC surveillance/communication analysis and planning --- including ASR radar, beacon interference locator, and transponder analyzer [AD-783184] N75-17326

RADIO NAVIGATION
Aeroflight communications and RF nav aids --- for space shuttle orbiters A75-23912

RAIN IMPACT DAMAGE
A model for rain erosion of homogeneous materials --- mass loss estimation A75-25185

Influence of velocity, impingement angle, heating, and aerodynamic shock layers on erosion of materials at velocities of 5500 ft per s /1700 m per s/ A75-25188

Effects of fatigue and dynamic recovery on rain erosion --- plastic coatings and composite materials tests A75-25189

RAPID TRANSIT SYSTEMS
The aerodynamics of vehicles in finite length tubes [PB-236692/0] N75-18192

RAREFIED GASES
Stationary reaction of a dual-sphere configuration moving in a free-molecular medium --- heat and energy transfer in rarefied gases [HEPT-36/1973] N75-18172

REAL GASES
Hypersonic viscous slip flow over an insulated flat plate with real gas effects A75-23205

REAL TIME OPERATION
Flexibility objectives for real-time telemetry processing systems --- four block model A75-23887

The future of real time telemetry systems --- for computerized testing of aerospace vehicles A75-23889

RECORDING INSTRUMENTS
The defect recording system and defect statistics for aircraft technology used by the CSA A75-23047

REDUNDANT COMPONENTS
Mechanization of and experience with a triplex fly-by-wire backup control system N75-18248

REENTRY VEHICLES
Aerodynamic heating of supersonic blunt bodies [AD-A001135] N75-18190

REFUELING
Fuelling systems --- at airports A75-25275

REGULATIONS
Noise legislation and regulations A75-23436

REINFORCED PLASTICS
Development of a VFW-614 spoiler in a design utilizing boron fiber reinforced plastic [DGLR PAPER 74-121] A75-24158

REINFORCING FIBERS

Evaluation of stiffness coefficients for fiber-reinforced laminated composites A75-23667

Potential contribution of high strength, high modulus aramid fibers to the commercial feasibility of lighter than air craft A75-25992

RELIABILITY ANALYSIS
Reliability of airframes --- Russian book on quality control during planning, production and maintenance A75-23428

Predicting instrumental reliability of automated aircraft system monitoring based on critical parameter A75-23810

Warranties as a life-cycle-cost management tool --- for military aircraft equipment A75-26099

REMOTE CONTROL
Study of solid state remote control techniques as applied to the redesign of the electrical system in a large civil aircraft [ARC-CP-1289] N75-17364

REMOTE SENSORS
Nonintrusive ultrasonic measurement of flow velocity and mass flow rate A75-22880

Problems in the integration of infrared line scanners in high-performance aircraft [DGLR PAPER 74-94] A75-24143

REMOTELY PILOTED VEHICLES
A preliminary investigation of remotely piloted vehicles for airframe noise research [AIAA PAPER 75-512] A75-25778

Remotely piloted LTA vehicle for surveillance A75-26028

RESEARCH AIRCRAFT
An LTA flight research vehicle --- airship development A75-26003

Results of intercomparison flights between the NAE-T-33 and the NCAR Buffalo atmospheric Research aircraft [AD-A001436] N75-17352

RESEARCH AND DEVELOPMENT
Developmental programs for small expendable turbojets A75-24946

Aircraft flyover noise measurements [AIAA PAPER 75-537] A75-25799

The NASA research program on propulsion for supersonic cruise aircraft [NASA-TM-X-71666] N75-18238

RESEARCH PROJECTS
A flight research program to develop airborne systems for improved terminal area operations A75-24803

YF-17 flight test program - Lightweight fighter program A75-24809

Technology for improved safety --- for general aviation [AIAA PAPER 75-291] A75-25008

NASA's role in aeronautics A75-25713

RESONANT FREQUENCIES
Fundamental frequency of a square panel with multiple point supports on edges A75-22798

Target identification by natural resonance estimation --- radar signatures A75-25878

A spatial theory for the ground resonance of helicopters --- noting fuselage rotation degrees of freedom [ESRO-TT-108] N75-17297

REYNOLDS NUMBER
Experimental determination of the separation point of flow around a circular cylinder A75-22868

RIBS (SUPPORTS)
Substantiation of discrete-continuum low-aspect-ratio wing structural analysis scheme A75-23798

RIGID ROTORS

Flapping response characteristics of hingeless rotor blades by a generalized harmonic balance method
[NASA-TN-D-7856] N75-18183

RIGID STRUCTURES

Where do we go from here --- in airship technology A75-25970
Mooring and ground handling rigid airships A75-25996

RING LASERS

Laser gyro reaction time investigation program
[AD-A001646] N75-17332

ROCKET LAUNCHERS

Analysis and design of a multiaxis vibration isolator for missile pods mounted on Army helicopters
[AD-A001459] N75-18225

ROCKET THRUST

Fluidic ejection seat control system A75-25052

ROOFS

An investigation of rooftop STOL port aerodynamics
[NASA-CR-132570] N75-17381

ROTARY WING AIRCRAFT

Aerocrane - A hybrid LTA aircraft for aerial crane applications A75-26019

ROTARY WINGS

N/C tape laying - Tomorrow's future today --- for helicopter rotor blade manufacturing
[SME PAPER M574-729] A75-23441
Noise of high speed rotors --- theory for propeller and helicopter configurations
[AIAA PAPER 75-450] A75-25732
Discrete frequency rotor noise --- from helicopters
[AIAA PAPER 75-451] A75-25733
V/STOL rotor and propeller noise - Its prediction and analysis of its aural characteristics
[AIAA PAPER 75-452] A75-25734
Thickness noise of helicopter rotors at high tip speeds
[AIAA PAPER 75-453] A75-25735
The development of experimental techniques for the study of helicopter rotor noise
[AIAA PAPER 75-455] A75-25736
An aeroelastic model helicopter rotor
[ARC-CP-1288] N75-17304
Development of an analysis for the determination of coupled helicopter rotor/control system dynamic response. Part 1: Analysis and applications
[NASA-CR-2452] N75-18178
Flapping response characteristics of hingeless rotor blades by a generalized harmonic balance method
[NASA-TN-D-7856] N75-18183

ROTOR AERODYNAMICS

Aerodynamics of the propellers of rapidly convertible VTOL aircraft A75-24942
Noncompact source effect on the prediction of tone noise from a fan rotor
[AIAA PAPER 75-446] A75-25730
Noise of high speed rotors --- theory for propeller and helicopter configurations
[AIAA PAPER 75-450] A75-25732
V/STOL rotor and propeller noise - Its prediction and analysis of its aural characteristics
[AIAA PAPER 75-452] A75-25734
Development of an analysis for the determination of coupled helicopter rotor/control system dynamic response. Part 1: Analysis and applications
[NASA-CR-2452] N75-18178
Flapping response characteristics of hingeless rotor blades by a generalized harmonic balance method
[NASA-TN-D-7856] N75-18183

ROTOR BLADES

On stress in service condition and estimated fatigue life of blades in axial flow compressor A75-23152
Broadband noise generated by turbulent inflow to rotor or stator blades in an annular duct
[NASA-CR-2503] N75-17361

ROTOR BLADES (TURBOMACHINERY)

Automatic balancing of rotors in high-speed machines --- Russian book on turbomachines A75-23397

A study of subsonic fan noise sources
[AIAA PAPER 75-468] A75-25744

Acoustic test results from a 36 inch (0.914m) statorless lift fan with serrated and unserrated rotor blades
[NASA-CR-137622] N75-18242

ROTOR SPEED

Thickness noise of helicopter rotors at high tip speeds
[AIAA PAPER 75-453] A75-25735

RUDDERS

System design of a rudder coordination system --- optimization computer program
[NASA-CR-142245] N75-18223

RUNWAY CONDITIONS

Civil aircraft airworthiness data recording programme. Uneven runways encountered by subsonic jet transport aircraft during scheduled airline operations
[ARC-CP-1287] N75-17383

S**S-N DIAGRAMS**

On stress in service condition and estimated fatigue life of blades in axial flow compressor A75-23152

S-3 AIRCRAFT

S-3A Design-to-a-Cost program
[SME PAPER M574-710] A75-23439

SAAB 37 AIRCRAFT

Report on spin test of AJ37 Viggen A75-24807

SAFEGUARD SYSTEM

Corporate/executive aircraft passenger safety - An educational approach A75-25874

SAFETY MANAGEMENT

Fire-fighting in airport premises A75-25342

SANDWICH STRUCTURES

Static computation of a wing model made of carbon fiber reinforced plastic /bending-torsion box/ with the aid of the method of finite elements and a comparison with experimental values
[DGLR PAPER 74-118] A75-24155
Development of the inlet ramp of a supersonic aircraft, employing a design which utilizes a fiber composite material
[DGLR PAPER 74-120] A75-24157

SCALE MODELS

Model and full scale test results relating to fan noise in-flight effects
[AIAA PAPER 75-465] A75-25741
Forward velocity effects on under-the-wing externally blown flap noise
[AIAA PAPER 75-476] A75-25750
Airframe noise measurements on a transport model in a quiet flow facility
[AIAA PAPER 75-509] A75-25775
An aeroelastic model helicopter rotor
[ARC-CP-1288] N75-17304

SEA STATES

Preliminary ride-quality evaluation of the HM.2 Hoverferry
[NASA-CR-142290] N75-17338

SEALING

A leak-free mechanical tube joint A75-23240

SEATS

A crashworthy armored helicopter crew seat A75-25055

SELF ADAPTIVE CONTROL SYSTEMS

Adaption processes in aircraft guidance systems
[AD-A000354] N75-17329

SELF LUBRICATING MATERIALS

Study of materials and nonmetallic coatings for erosion and wear resistance A75-23942

SEPARATED FLOW

Experimental determination of the separation point of flow around a circular cylinder A75-22868

SERVICE LIFE

SUBJECT INDEX

- Studies of separated flows --- interaction of turbulent boundary layers with inviscid flow around transonic airfoils
[AD-A000348] N75-17626
- SERVICE LIFE**
On stress in service condition and estimated fatigue life of blades in axial flow compressor
A75-23152
Warranties as a life-cycle-cost management tool --- for military aircraft equipment
A75-26099
- SERVOMECHANISMS**
Airfoil optimization utilizing a remotely controlled flexible model. Phase 1: Low speed wind tunnel test
[AD-A001094] N75-18189
- SHEAR LAYERS**
The viscous flow around a two dimensional high lift wing. Analysis of boundary layer measurements
[FFA-TN-AU-1155] N75-17310
- SHEAR STRESS**
Calculation of turbulent shear stress in supersonic boundary-layer flows
A75-23209
Turbulent wake behind slender bodies including self-propelled configurations
[AD-A001040] N75-17319
- SHELL STABILITY**
Aeroelasticity of plates and shells --- Book
A75-25180
- SHOCK LAYERS**
Entropy layer on a supersonic plane flat nose at incidence
A75-23208
Influence of velocity, impingement angle, heating, and aerodynamic shock layers on erosion of materials at velocities of 5500 ft per s /1700 m per s/
A75-25188
- SHOCK WAVE GENERATORS**
Supersonic flow of a lightly dust-laden gas past a wedge
A75-23298
- SHOCK WAVE PROFILES**
Numerical solutions for supersonic corner flow
A75-23295
- SHOCK WAVE PROPAGATION**
The diffraction of a shock wave by a slender body
A75-25458
- SHORT HAUL AIRCRAFT**
Operational considerations for the airship in short-haul transportation
A75-25993
- SHORT TAKEOFF AIRCRAFT**
Advanced composite design concepts for the AMST
[SAE PAPER 740870] A75-22944
RTOL and steep approach - Why
[DGLR PAPER 74-112] A75-24152
Fluctuating pressures on aircraft wing and flap surfaces associated with powered-lift systems
[AIAA PAPER 75-472] A75-25747
Theoretical and experimental study on the ejector augmented jet flap
[NASA-CR-136749] N75-17296
Results of intercomparison flights between the NAE-T-33 and the NCAR Buffalo atmospheric Research aircraft
[AD-A001436] N75-17352
Methods for predicting the aerodynamic and stability and control characteristics of STOL aircraft. Volume 1: Basic theoretical methods
[AD-A001580] N75-17375
Methods for predicting the aerodynamic and stability and control characteristics of STOL aircraft. Volume 2: STOL aerodynamic methods computer program
[AD-A001581] N75-17376
Methods for predicting the aerodynamic and stability and control characteristics of STOL aircraft. Volume 3: Engineering methods
[AD-A001582] N75-17377
An investigation of rooftop STOL port aerodynamics
[NASA-CR-132570] N75-17381
An experimental simulation study of four crosswind landing gear concepts
[NASA-TN-D-7864] N75-18184
- Analytical study of ventilated wind tunnel boundary interference on V/STOL models including wake curvature and decay effects
[NASA-CR-142240] N75-18188
Report on program to improve MIL-F-83300 --- simulation of short takeoff aircraft longitudinal characteristics
[AD-A001598] N75-18226
The flight investigation and analysis of longitudinal handling qualities of STOL aircraft on landing approach
[AD-A001596] N75-18254
Acoustic transmission through a fuselage sidewall
[NASA-CR-132602] N75-18971
- SIDE-LOOKING RADAR**
SLAR, its principles of operation and requirements regarding the positional stability of carrier platforms
A75-25697
- SIDELobe REDUCTION**
Laterally displaced ISLS antenna for tactical radar --- Interrogation Side Lobe Suppression
A75-25926
- SIGNAL PROCESSING**
Advanced signal processing for airport surveillance radars
A75-26037
- SILENCERS**
The effects of forward speed on a number of turbojet exhaust silencers
[AIAA PAPER 75-506] A75-25772
- SINGULAR INTEGRAL EQUATIONS**
Approximate solution of integral equations with a singular operator --- for wing motion
A75-24835
- SINGULARITY (MATHEMATICS)**
Review of integral-equation techniques for solving potential-flow problems with emphasis on the surface-source method
A75-25120
- SKIN FRICTION**
Skin friction reduction in supersonic flow by injection through slots, porous sections and combinations of the two
[NASA-CR-2491] N75-17614
- SLENDER BODIES**
The diffraction of a shock wave by a slender body
A75-25458
A limiting case of multiphase flow past slender bodies
[AD-A000240] N75-17313
Turbulent wake behind slender bodies including self-propelled configurations
[AD-A001040] N75-17319
- SLENDER WINGS**
An experimental investigation of noise-shielding effects for a delta-winged aircraft in flight, wind tunnel and anechoic room
[AIAA PAPER 75-513] A75-25779
- SLIP FLOW**
Hypersonic viscous slip flow over an insulated flat plate with real gas effects
A75-23205
- SOIL MECHANICS**
Mechanical instability ground dynamics program
[AD-A001101] N75-17349
- SOLID PROPELLANTS**
Practical applications of acoustic emission --- for pressure vessels, aircraft structures and solid propellants
A75-24461
- SOLID STATE**
Factors in the design of solid oxygen systems for aircraft
A75-25061
- SOLID STATE DEVICES**
Study of solid state remote control techniques as applied to the redesign of the electrical system in a large civil aircraft
[ARC-CP-1289] N75-17364
- SOLVENT EXTRACTION**
Jet fuel thermal stability improvements through fuel processing
[AD-A001623] N75-17531
- SONIC BOOMS**
Atmospheric refraction of sonic boom from aircraft at low supersonic speeds
[AIAA PAPER 75-547] A75-25809

SOUND FIELDS

- Jet noise source location by cross-correlation of far field microphone signals
[AIAA PAPER 75-456] A75-25737
- The near field sound pressures of a choked jet when oscillating in the spinning mode
[AIAA PAPER 75-479] A75-25752

SOUND GENERATORS

- Practical applications of acoustic emission --- for pressure vessels, aircraft structures and solid propellants A75-24461

SOUND LOCALIZATION

- Jet noise source location by cross-correlation of far field microphone signals
[AIAA PAPER 75-456] A75-25737

SOUND PRESSURE

- The development of experimental techniques for the study of helicopter rotor noise
[AIAA PAPER 75-455] A75-25736

SOUND PROPAGATION

- Propagation of sound in elliptic ducts A75-22791

- Sound propagation in curved ducts
[AIAA PAPER 75-497] A75-25766

- Acoustic wave propagation in a lined duct with non-uniform admittance
[AIAA PAPER 75-515] A75-25781

- Effects of a conical segment on sound radiation from a circular duct
[AIAA PAPER 75-517] A75-25783

- Generalized wave envelope analysis of sound propagation in ducts with stepped noise source profiles and variable axial impedance
[AIAA PAPER 75-518] A75-25784

- Propagation of aircraft noise over long distances through the lower atmosphere
[AIAA PAPER 75-542] A75-25804

SOUND TRANSMISSION

- Atmospheric refraction of sonic boom from aircraft at low supersonic speeds
[AIAA PAPER 75-547] A75-25809
- Acoustic transmission through a fuselage sidewall
[NASA-CR-132602] N75-18971

SOUND WAVES

- On the excess attenuation of sound in the atmosphere
[NASA-TN-D-7823] N75-18030

SPACE SHUTTLE ORBITERS

- Aeroflight communications and RF nav aids --- for space shuttle orbiters A75-23912

SPACECRAFT PERFORMANCE

- 1974 report to the aerospace profession; Proceedings of the Eighteenth Symposium, Beverly Hills, Calif., September 25-28, 1974 A75-24802

SPACECRAFT RELIABILITY

- Aeroflight communications and RF nav aids --- for space shuttle orbiters A75-23912

SPHERICAL WAVES

- Effects of a conical segment on sound radiation from a circular duct
[AIAA PAPER 75-517] A75-25783

SPIN TESTS

- Report on spin test of AJ37 Viggen A75-24807
- Instrumentation and control system for an F-15 stall/spin
[NASA-TM-X-72647] N75-17353

SPOILERS

- The Alpha-Jet spoiler of carbon-epoxy material
[DGLR PAPER 74-119] A75-24156
- Development of a VFW-614 spoiler in a design utilizing boron fiber reinforced plastic
[DGLR PAPER 74-121] A75-24158

STABILITY DERIVATIVES

- Input design for identification of aircraft stability and control derivatives
[NASA-CR-2493] N75-17370

STABILIZED PLATFORMS

- Design analysis of helicopter automatic and semiautomatic airborne precision pointing and tracking systems
[AD-A000834] N75-18229

STABILIZERS (FLUID DYNAMICS)

- On empennage stability --- aircraft control surface deflection A75-23802

STAGNATION PRESSURE

- Miniature probe for transonic flow direction measurements A75-23224

STATE VECTORS

- A state-variable design approach for a high-performance aerospace vehicle pitch orientation system with variable coefficients A75-23457

STATIC AERODYNAMIC CHARACTERISTICS

- Aerodynamic testing technique for twin fuselage models at hypersonic speeds
[NASA-TM-X-3196] N75-18187

STATIC PRESSURE

- Static pressure on sharp and blunt cones in conical and parallel low-density flow
[AD-A001632] N75-18191

STATIC TESTS

- Static structural test for supersonic aircraft --- Russian book A75-23233

STATISTICAL ANALYSIS

- The defect recording system and defect statistics for aircraft technology used by the CSA A75-23047
- Statistical review of counting accelerometer data for Navy and Marine fleet aircraft
[AD-A000092] N75-17355
- Development of a non-survey method estimating traffic at nontowered airports
[AD-A002397] N75-18263

STATOR BLADES

- NASA vane alloy boasts high-temperature strength A75-24003

STIFFNESS MATRIX

- Evaluation of stiffness coefficients for fiber-reinforced laminated composites A75-23667
- An iterative improvement for finite element analysis A75-25212

STRAIN ENERGY METHODS

- Evaluation of stiffness coefficients for fiber-reinforced laminated composites A75-23667

STRATOSPHERE

- Measurements of supersonic jet aircraft wakes in the stratosphere A75-23962
- Stratospheric pollution - Aircraft engine emissions in the region above the tropopause as a function of aircraft altitude and tropopause height A75-23965
- Possible climatic effects of supersonic transports A75-23973
- First results of a general circulation model applied to the SST-N0x problem --- ozone decomposition A75-23982

STREAM FUNCTIONS (FLUIDS)

- The determination of the subsonic flow of a Chaplygin gas around a circular profile in the presence of circulation A75-24061

STRESS ANALYSIS

- Stress analysis of aircraft fuselages and pressurized cabins --- Russian book A75-23231
- Analysis of thin-wall circular fuselage in damage zone A75-23801
- Static computation of a wing model made of carbon fiber reinforced plastic /bending-torsion box/ with the aid of the method of finite elements and a comparison with experimental values
[DGLR PAPER 74-118] A75-24155
- Stability theory and its applications to structural mechanics --- Book A75-25181

STRESS CONCENTRATION

- Calculation of turbulent shear stress in supersonic boundary-layer flows A75-23209
- Load distribution on threads of titanium tension nuts and steel bolts
[ASME PAPER 74-DE-N] A75-23638
- A new biaxial tensile testing machine A75-24068

STRESS CORROSION CRACKING

SUBJECT INDEX

STRESS CORROSION CRACKING

Hot corrosion in gas turbines

A75-24380

STRESS CYCLES

On stress in service condition and estimated fatigue life of blades in axial flow compressor

A75-23152

STRESS-STRAIN DIAGRAMS

Stress-strain state and springback in elastic-plastic torsion of profiles with open cross section contour

A75-23809

STRINGERS

Analysis of thin-wall circular fuselage in damage zone

A75-23801

STRUCTURAL ANALYSIS

Matrix difference equation analysis of vibrating periodic structures --- aircraft engine parts

A75-23201

Substantiation of discrete-continuum

low-aspect-ratio wing structural analysis scheme

A75-23798

LTA structures and materials technology --- airships

A75-25991

Structural response of a fiber composite

compressor fan blade airfoil

[NASA-TN-X-71623]

N75-17709

STRUCTURAL DESIGN

Advanced composite design concepts for the AMST

[SAE PAPER 740870]

A75-22944

Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings

A75-25969

Computer aided flexible envelope designs

A75-25989

Technology update - Tethered aerostat structural design and material developments

A75-26024

Optimization of structures to satisfy a flutter velocity constraint by use of quadratic equation fitting

[NASA-CR-132628]

N75-17711

STRUCTURAL DESIGN CRITERIA

An aerodynamic load criterion for airships

A75-25985

The use of titanium and its alloys in the manufacture of helicopters and aircraft structures

[BR44857]

N75-17337

STRUCTURAL FAILURE

Analysis of thin-wall circular fuselage in damage zone

A75-23801

STRUCTURAL INFLUENCE COEFFICIENTS

The response of a vibrating structure as a function of structural parameters

A75-22796

STRUCTURAL RELIABILITY

A leak-free mechanical tube joint

A75-23240

Reliability of airframes --- Russian book on quality control during planning, production and maintenance

A75-23428

STRUCTURAL STABILITY

Stability theory and its applications to structural mechanics --- Book

A75-25181

STRUCTURAL VIBRATION

The response of a vibrating structure as a function of structural parameters

A75-22796

Fundamental frequency of a square panel with multiple point supports on edges

A75-22798

On the natural vibration of plate-beam combination structures, 4

[NAL-TR-363]

N75-17707

Optimization of structures to satisfy a flutter velocity constraint by use of quadratic equation fitting

[NASA-CR-132628]

N75-17711

STRUCTURAL WEIGHT

The basic characteristics of hybrid aircraft

A75-26005

SUBSONIC AIRCRAFT

Advanced subsonic transports - A challenge for the 1990's

[AIAA PAPER 75-304]

A75-23251

SUBSONIC FLOW

The determination of the subsonic flow of a Chaplygin gas around a circular profile in the presence of circulation

A75-24061

The subsonic-supersonic analogy --- for flow around wing profiles

A75-25459

New evidence of subsonic jet noise mechanisms

[AIAA PAPER 75-437]

A75-25724

Application of a variational method in plane compressible flow calculation --- steady inviscid plane subsonic flow past an airfoil

[ARC-CP-1284]

N75-17303

SUBSONIC SPEED

A study of subsonic fan noise sources

[AIAA PAPER 75-468]

A75-25744

SUBSONIC WIND TUNNELS

Optimization of wind tunnel nozzles for the subsonic range

A75-24271

Theoretical and experimental study on the ejector

augmented jet flap

[NASA-CR-136749]

N75-17296

SUPERCRITICAL FLOW

Contribution to the study of supercritical profile flow

[DGLR PAPER 74-99]

A75-24146

SUPERCRITICAL WINGS

Transonic wing design and its effects on flight performance

[DGLR PAPER 74-97]

A75-24144

Development and wind tunnel investigation of three supercritical airfoil profiles for transport aircraft

[DGLR PAPER 74-100]

A75-24147

Supercritical wing sections 2, volume 108

[NASA-CR-142229]

N75-18167

SUPERSONIC AIRCRAFT

Static structural test for supersonic aircraft --- Russian book

A75-23233

Development of the inlet ramp of a supersonic aircraft, employing a design which utilizes a fiber composite material

[DGLR PAPER 74-120]

A75-24157

Atmospheric refraction of sonic boom from aircraft at low supersonic speeds

[AIAA PAPER 75-547]

A75-25809

The NASA research program on propulsion for supersonic cruise aircraft

[NASA-TN-X-71666]

N75-18238

Wall corrections in transonic square test sections with perforated walls. Influence of the model span on lift corrections

[AD-A000138]

N75-18266

SUPERSONIC BOUNDARY LAYERS

Calculation of turbulent shear stress in supersonic boundary-layer flows

A75-23209

SUPERSONIC COMBUSTION RAMJET ENGINES

Simulation of hypersonic scramjet exhaust --- pressure distribution on afterbody/nozzle sections of vehicle

[NASA-CR-2494]

N75-17344

SUPERSONIC COMPRESSORS

Flow determination at the exit of a moving supersonic annular blade cascade

[ONERA, TP NO. 1370]

A75-23946

SUPERSONIC FLIGHT

Hydrocarbon emissions from jet engines operated at simulated high-altitude supersonic flight conditions

A75-23963

Emission calibration of a J-58 afterburning turbojet engine at simulated supersonic, stratospheric flight conditions

A75-23964

SUPERSONIC FLOW

The scattering of sound by a vortex sheet

A75-22934

- The effect of initial values on wing form and the limiting curve of the wave drag coefficients of optimized symmetrical-thick delta wings in supersonic flow
A75-23100
- Entropy layer on a supersonic plane flat nose at incidence
A75-23208
- Numerical solutions for supersonic corner flow
A75-23295
- Supersonic flow of a lightly dust-laden gas past a wedge
A75-23298
- The subsonic-supersonic analogy --- for flow around wing profiles
A75-25459
- Effect of geometry on open cavity flow-induced pressure oscillations
[AIAA PAPER 75-492] A75-25761
- Skin friction reduction in supersonic flow by injection through slots, porous sections and combinations of the two
[NASA-CR-2491] N75-17614
- SUPERSONIC INLETS**
- Development of the inlet ramp of a supersonic aircraft, employing a design which utilizes a fiber composite material
[DGLR PAPER 74-120] A75-24157
- Concorde inlet system and peripheral envelope flight testing
A75-24804
- Measurement of the internal performance of a rectangular air intake mounted on a fuselage at Mach numbers from 1.6 to 2, part 4
[ARC-CP-1291] N75-17305
- SUPERSONIC JET FLOW**
- Experiments on supersonic jet noise
[AIAA PAPER 75-478] A75-25751
- The near field sound pressures of a choked jet when oscillating in the spinning mode
[AIAA PAPER 75-479] A75-25752
- Ambient and induced pressure fluctuations in supersonic jet flows --- acoustic tracing of noise source
[AIAA PAPER 75-482] A75-25754
- SUPERSONIC SPEEDS**
- Influence of velocity, impingement angle, heating, and aerodynamic shock layers on erosion of materials at velocities of 5500 ft per s /1700 m per s/
A75-25188
- Noise of high speed rotors --- theory for propeller and helicopter configurations
[AIAA PAPER 75-450] A75-25732
- Aerodynamic design and analysis system for supersonic aircraft. Part 1: General description and theoretical development
[NASA-CR-2520] N75-18185
- Aerodynamic design and analysis system for supersonic aircraft. Part 3: Computer program description
[NASA-CR-2522] N75-18186
- Aerodynamic heating of supersonic blunt bodies
[AD-A001135] N75-18190
- Engine/airframe compatibility studies for supersonic cruise aircraft
[NASA-CR-132610] N75-18221
- SUPERSONIC TRANSPORTS**
- Possible climatic effects of supersonic transports
A75-23973
- First results of a general circulation model applied to the SST-NOx problem --- ozone decomposition
A75-23982
- Study of active cooling for supersonic transports
[NASA-CR-132573] N75-17336
- SUPERSONIC WAKES**
- Measurements of supersonic jet aircraft wakes in the stratosphere
A75-23962
- SURFACE GEOMETRY**
- Review of integral-equation techniques for solving potential-flow problems with emphasis on the surface-source method
A75-25120
- SURFACE PROPERTIES**
- Study of materials and nonmetallic coatings for erosion and wear resistance
A75-23942
- Noise radiation from turbulent flows over compliant surfaces
[AIAA PAPER 75-507] A75-25773
- Computer aided flexible envelope designs
A75-25989
- SURFACE ROUGHNESS**
- Civil aircraft airworthiness data recording programme. Uneven runways encountered by subsonic jet transport aircraft during scheduled airline operations
[ARC-CP-1287] N75-17383
- SURVEILLANCE**
- Surveillance velocity measurements with least maximum error
A75-25928
- SURVEILLANCE RADAR**
- Advanced signal processing for airport surveillance radars
A75-26037
- DABS - Projected performance and experimental results --- Discrete Address Beacon System for ATC
A75-26061
- SURVIVAL EQUIPMENT**
- Survival and Flight Equipment Association, Annual Conference and Trade Exhibit, 12th, Las Vegas, Nev., September 8-12, 1974, Proceedings
A75-25051
- Corporate/executive aircraft passenger safety - An educational approach
A75-25874
- SUSPENDING (HANGING)**
- Long fluid filled bags suspended by line forces --- for airship design
A75-25988
- SWEEPBACK**
- Wind tunnel investigations on an airplane model with variable sweepback in the incompressible region. Part 1: Comparison of the most important experimental parameters and their influence on the aerodynamic coefficients
[IFD-4/73-PT-1] N75-17298
- SWEEP WINGS**
- Transonic wing design and its effects on flight performance
[DGLR PAPER 74-97] A75-24144
- Application of the equivalent mechanical flap concept to jet flapped wing-body combinations
[AD-A000431] N75-17346
- SWEEPBACK WINGS**
- Low speed wind tunnel test of jet flaps and floating wingtip ailerons on a fighter wing
[AD-A000809] N75-17318
- SWIRLING**
- Minimization of jet and core noise of a turbojet engine by swirling the exhaust flow
[AIAA PAPER 75-503] A75-25769
- SWITCHING CIRCUITS**
- Aircraft switching devices: Fabrication technology and installation --- Russian book
A75-23369
- SYNTHETIC FIBERS**
- Potential contribution of high strength, high modulus aramid fibers to the commercial feasibility of lighter than air craft
A75-25992
- SYSTEM EFFECTIVENESS**
- Performance survey of the air traffic control radar beacon system
A75-23459
- Aero-marine communications by satellite
A75-24100
- SYSTEMS ANALYSIS**
- The design of flight control devices with the aid of modern system theory
[DGLR PAPER 74-77] A75-24134
- Ground-based collision avoidance systems for air traffic
A75-26062
- Aerodynamic design and analysis system for supersonic aircraft. Part 1: General description and theoretical development
[NASA-CR-2520] N75-18185
- Aerodynamic design and analysis system for supersonic aircraft. Part 3: Computer program description
[NASA-CR-2522] N75-18186

SYSTEMS COMPATIBILITY

SUBJECT INDEX

SYSTEMS COMPATIBILITY

- APTI TI-1 program --- Advanced Fighter Technology
Integration
[SAE PAPER 740860] A75-22939
- SYSTEMS ENGINEERING**
A state-variable design approach for a
high-performance aerospace vehicle pitch
orientation system with variable coefficients
A75-23457
Control, stabilization, and guidance of flight
vehicles
[DGLR PAPER 74-75] A75-24133
The devising of control systems with the help of
computer-aided design and their application
[DGLR PAPER 74-78] A75-24135
Modern control - Modeling and application in real
aircraft flight control system design
A75-24758
VTOL flight-control system design using
sensitivity analysis
A75-25879
- SYSTEMS STABILITY**
Stability theory and its applications to
structural mechanics --- Book
A75-25181

T

T TAIL SURFACES

- Wind tunnel investigation of aerodynamic loads on
a large-scale externally blown flap model and
comparison with theory
[NASA-TN-D-7863] N75-17294

TAIL SURFACES

- On empennage stability --- aircraft control
surface deflection
A75-23802

TAKEOFF

- VTOL airplane control in transition regimes
[AD-A000128] N75-17378
An experimental simulation study of four crosswind
landing gear concepts
[NASA-TN-D-7864] N75-18184

TANKER SHIPS

- Airships for transporting highly volatile
commodities --- compared with ocean tankers and
gas pipelines
A75-26017

TARGET RECOGNITION

- Target identification by natural resonance
estimation --- radar signatures
A75-25878
High range-resolution monopulse tracking radar and
applications --- for target recognition
A75-26041

TECHNOLOGICAL FORECASTING

- Advanced subsonic transports - A challenge for the
1990's
[AIAA PAPER 75-304] A75-23251
The future of real time telemetry systems --- for
computerized testing of aerospace vehicles
A75-23889
The shape of the future long-haul transport airplane
[AIAA PAPER 75-305] A75-25012
Recent advances in the technology of aircraft
noise control
[AIAA PAPER 75-317] A75-25014
Where do we go from here --- in airship technology
A75-25970
Balloon logging with the inverted skyline ---
timber transport system
A75-26026
An overview of the upgraded third generation air
traffic control system
A75-26059

TECHNOLOGY ASSESSMENT

- Applications of electronic data processing in
aircraft maintenance
A75-23048
A solution to the transport of exceptionally large
loads - The dirigible
A75-23199
Aids to air navigation
A75-23349
Digital avionics - An established technology
A75-24049
The technology of the aircraft MRCA and its systems
[DGLR PAPER 74-63] A75-24129

- Aerospace technology - Planning methodology and
defense-technological objectives
[DGLR PAPER 74-67] A75-24130
Development trends in aircraft design --- economic
analysis
[DGLR PAPER 74-68] A75-24131
Control, stabilization, and guidance of flight
vehicles
[DGLR PAPER 74-75] A75-24133
F-15 update report
A75-24806
NASA general aviation technology programs
[AIAA PAPER 75-290] A75-25007
Technology for improved safety --- for general
aviation
[AIAA PAPER 75-291] A75-25008
Recent advances in the technology of aircraft
noise control
[AIAA PAPER 75-317] A75-25014
Recent advances in exhaust systems for jet noise
suppression of high speed aircraft
[AIAA PAPER 75-333] A75-25016
Interagency Workshop on Lighter than Air Vehicles,
Monterey, Calif., September 9-13, 1974,
Proceedings
A75-25969
An economic comparison of three heavy lift
airborne systems
A75-25978
Market assessment in connection with lighter than
air --- airships
A75-25980
Basic relationships for LTA technical analysis ---
performance evaluation
A75-25981
LTA structures and materials technology --- airships
A75-25991
Lighter than air - A look at the past, a look at
the possibilities
A75-25995
The State all metal airship --- design and
historical survey
A75-25998
State of the art of metalclad airships
A75-25999
The aerospace developments concept --- airship
design for natural gas transport
A75-26000
Unmanned powered balloons
A75-26020
Special problems and capabilities of high altitude
lighter than air vehicles --- superpressure
powered aerostat design
A75-26021
AEROSAT test and evaluation avionics ---
aeronautical satellite communication system for
oceanic ATC
A75-26043
Engine/airframe compatibility studies for
supersonic cruise aircraft
[NASA-CR-132610] N75-18221
- TECHNOLOGY UTILIZATION**
APTI TI-1 program --- Advanced Fighter Technology
Integration
[SAE PAPER 740860] A75-22939
Areas of ECM application, opportunities and
limitations --- electrochemical machining
technology
A75-23693
Development and use of types of construction
employing fiber-reinforced materials --- German
book on aircraft materials
[DGLR PAPER 14-117] A75-24154
Practical applications of acoustic emission ---
for pressure vessels, aircraft structures and
solid propellants
A75-24461
The use of digital computers in air traffic control
A75-25862
Effect of present technology on airship capabilities
A75-25974
Potential contribution of high strength, high
modulus aramid fibers to the commercial
feasibility of lighter than air craft
A75-25992
Military applications of rigid airships --- aerial
surveillance and cargo transport
A75-26013

- 'LOTS' of LTA applications --- Logistics Over The Shore operations
A75-26027
- Remotely piloted LTA vehicle for surveillance
A75-26028
- TELECOMMUNICATION**
A revolutionary and operational tethered aerostat system illustrating new LTA technology
A75-26023
- TELEMETRY**
Flexibility objectives for real-time telemetry processing systems --- four block model
A75-23887
- TEMPERATURE CONTROL**
Study of active cooling for supersonic transports [NASA-CR-132573]
N75-17336
- TEMPERATURE EFFECTS**
Core engine noise due to temperature fluctuations convecting through turbine blade rows [AIAA PAPER 75-528]
A75-25791
- TENSILE TESTS**
Fracture mechanics' impact on specifications and supply --- test methods for aircraft aluminum alloys
A75-24004
- A new biaxial tensile testing machine
A75-24068
- TERMINAL FACILITIES**
Mobile lounge or fixed gate --- airport terminal design
A75-25343
- Mooring and ground handling rigid airships
A75-25996
- TERMINAL GUIDANCE**
A flight research program to develop airborne systems for improved terminal area operations
A75-24803
- TERRAIN FOLLOWING AIRCRAFT**
Results of the investigation regarding two three-dimensional low-level flight control systems [DGLR PAPER 74-83]
A75-24139
- TEST FACILITIES**
Recent progress in experimental studies of afterbodies
A75-24943
- Test bed for the upgraded third generation Air Traffic Control System
A75-26064
- Some questions on the creation of an open stand for acoustic investigations of DTRD's --- development of facilities for testing turbofan engines [AD-A000660]
N75-17365
- TETHERED BALLOONS**
A practical concept for powered or tethered weight-lifting LTA vehicles
A75-26022
- A revolutionary and operational tethered aerostat system illustrating new LTA technology
A75-26023
- Technology update - Tethered aerostat structural design and material developments
A75-26024
- TF-30 ENGINE**
Design of a very-low-bleed Mach 2.5 mixed-compression inlet with 45 percent internal contraction [NASA-TM-X-3135]
N75-17363
- Digital implementation of the TF30-P-3 turbofan engine control [NASA-TM-X-3105]
N75-18239
- THERMAL MAPPING**
Problems in the integration of infrared line scanners in high-performance aircraft [DGLR PAPER 74-94]
A75-24143
- THERMAL RESISTANCE**
Investigation of the structure and properties of niobium in vacuum and in high-velocity air streams
A75-23009
- THERMAL STABILITY**
Laboratory evaluation of the stability of high-purity jet fuels of the T-8 type and of the effectiveness of antioxidants
A75-24274
- Jet fuel thermal stability improvements through fuel processing [AD-A001623]
N75-17531
- THERMODYNAMIC EFFICIENCY**
Thermodynamics of multistage air-cooled gas turbine
A75-23817
- THIN AIRFOILS**
Measurements of discrete vortex noise in a closed-throat wind tunnel [AIAA PAPER 75-488]
A75-25758
- THIN FILMS**
Survey of thin film fluorescent material --- for marking aircraft [AD-A005571]
N75-18194
- THIN WALLED SHELLS**
Analysis of thin-wall circular fuselage in damage zone
A75-23801
- THIN WINGS**
Static computation of a wing model made of carbon fiber reinforced plastic /bending-torsion box/ with the aid of the method of finite elements and a comparison with experimental values [DGLR PAPER 74-118]
A75-24155
- THREADS**
Load distribution on threads of titanium tension nuts and steel bolts [ASME PAPER 74-DE-N]
A75-23638
- THREE DIMENSIONAL FLOW**
Measured three-dimensional effects in transonic airfoil testing
A75-23222
- Review of integral-equation techniques for solving potential-flow problems with emphasis on the surface-source method
A75-25120
- THREE DIMENSIONAL MOTION**
Results of the investigation regarding two three-dimensional low-level flight control systems [DGLR PAPER 74-83]
A75-24139
- THROTTLING**
Compressor and turbine characteristic representation in algorithm for calculating turbojet engine throttling characteristics
A75-23822
- THRUST VECTOR CONTROL**
Fluidic ejection seat control system
A75-25052
- Vertical seeking ejection seat
A75-25053
- Methods for predicting the aerodynamic and stability and control characteristics of STOL aircraft. Volume 1: Basic theoretical methods [AD-A001580]
N75-17375
- Methods for predicting the aerodynamic and stability and control characteristics of STOL aircraft. Volume 2: STOL aerodynamic methods computer program [AD-A001581]
N75-17376
- Methods for predicting the aerodynamic and stability and control characteristics of STOL aircraft. Volume 3: Engineering methods [AD-A001582]
N75-17377
- TILT WING AIRCRAFT**
The effect of ground proximity on the lateral/directional aerodynamic and control characteristics of a tilt-wing V/STOL aircraft at high lift coefficients [AD-A001584]
N75-18227
- TIMBER INVENTORY**
Balloon logging with the inverted skyline --- timber transport system
A75-26026
- TIP SPEED**
Noise of high speed rotors --- theory for propeller and helicopter configurations [AIAA PAPER 75-450]
A75-25732
- Thickness noise of helicopter rotors at high tip speeds [AIAA PAPER 75-453]
A75-25735
- A study of subsonic fan noise sources [AIAA PAPER 75-468]
A75-25744
- TITANIUM ALLOYS**
Cost savings in the application of P/M titanium and P/M aluminum alloys
A75-23412
- The use of titanium and its alloys in the manufacture of helicopters and aircraft structures [BR44857]
N75-17337

TORSION

- Study of annular nozzle cascades with different
'reverse' vane twist A75-23818

TORSIONAL STRESS

- Stress-strain state and springback in
elastic-plastic torsion of profiles with open
cross section contour A75-23809

TRACKING RADAR

- High range-resolution monopulse tracking radar and
applications --- for target recognition A75-26041

TRAFFIC CONTROL

- Aero-marine communications by satellite A75-24100

TRAILING EDGES

- Measured three-dimensional effects in transonic
airfoil testing A75-23222

- Induced drag effect on airframe noise
[AIAA PAPER 75-487] A75-25757

- Trailing edge noise --- generated by oscillatory
flow on flat plate A75-25759

- Transonic wind tunnel tests on two blunt trailing
edge aerofoils N75-18175

- Wind tunnel investigation of the wake near the
trailing edge of a distributed
upper-surface-blown flap A75-18176

- [NASA-TM-X-72637] N75-18176

TRAILING-EDGE FLAPS

- Conversion factor for profile drag increment for
part-span flaps N75-18173

- [ESDU-FLAPS-02.01.07] N75-18173

TRANSFER FUNCTIONS

- Target identification by natural resonance
estimation --- radar signatures A75-25878

TRANSOCEANIC COMMUNICATION

- AEROSAT test and evaluation avionics ---
aeronautical satellite communication system for
oceanic ATC A75-26043

TRANSONIC FLIGHT

- Transonic wing design and its effects on flight
performance A75-24144

- [DGLR PAPER 74-97] A75-24144

TRANSONIC FLOW

- Miniature probe for transonic flow direction
measurements A75-23224

- Transonic profile design --- gas dynamic analysis
[DGLR PAPER 74-98] A75-24145

- Contribution to the study of supercritical profile
flow A75-24146

- [DGLR PAPER 74-99] A75-24146

- Studies of separated flows --- interaction of
turbulent boundary layers with inviscid flow
around transonic airfoils N75-17626

- [AD-A000348] N75-17626

- Transonic wind tunnel tests on two blunt trailing
edge aerofoils N75-18175

- [ARL/A-NOTE-351] N75-18175

- An analysis method for two-dimensional transonic
viscous flow N75-18179

- [NASA-TN-D-7718] N75-18179

TRANSONIC SPEED

- Low speed wind tunnel test of jet flaps and
floating wingtip ailerons on a fighter wing
[AD-A000809] N75-17318

TRANSONIC WIND TUNNELS

- Measured three-dimensional effects in transonic
airfoil testing A75-23222

- Transonic wind tunnel tests on two-dimensional
aerofoil sections Part 1: Determination of
pressure distribution and drag for an aerofoil
of type NLR 13 in PFA wind tunnel S5 N75-17299

- [PFA-TM-AU-725-PT-1] N75-17299

- Wall corrections in transonic square test sections
with perforated walls. Influence of the model
span on lift corrections N75-18266

- [AD-A000138] N75-18266

TRANSPORT AIRCRAFT

- Advanced subsonic transports - A challenge for the
1990's A75-23251

- [AIAA PAPER 75-304] A75-23251

- Development and wind tunnel investigation of three
supercritical airfoil profiles for transport
aircraft A75-24147

- [DGLR PAPER 74-100] A75-24147

- Recent wake turbulence flight test programs A75-24805

- The shape of the future long-haul transport airplane
[AIAA PAPER 75-305] A75-25012

- Where do we go from here --- in airship technology
A75-25970

- Analysis and preliminary design of an advanced
technology transport flight control system
[NASA-CR-2490] N75-17295

- Ice simulation: A 2-dimensional wind tunnel
investigation of a NACA 652A215 wing section
with single slotted flap. Part 2:
Configurations typical for transport airplanes
[PFA-TM-AU-995-PT-2] N75-17309

- Future long-range transports: Prospects for
improved fuel efficiency N75-17339

- [NASA-TM-X-72659] N75-17339

- Evaluation of routing and scheduling
considerations for possible future commercial
hypersonic transport aircraft N75-18193

- [NASA-CR-132632] N75-18193

TRANSPORT VEHICLES

- A practical concept for powered or tethered
weight-lifting LTA vehicles A75-26022

TRANSPORTATION

- The transport of nuclear power plant components
A75-26016

TROPOPAUSE

- Stratospheric pollution - Aircraft engine
emissions in the region above the tropopause as
a function of aircraft altitude and tropopause
height A75-23965

TRUNCATION ERRORS

- An iterative improvement for finite element analysis
A75-25212

TURBINE BLADES

- Study of annular nozzle cascades with different
'reverse' vane twist A75-23818

- Calculation of flutter boundary of dynamically
nonuniform profile cascades A75-23819

- NASA vane alloy boasts high-temperature strength
A75-24003

- Wake cutting by a cascade of cambered blades
[AIAA PAPER 75-445] A75-25729

- Core engine noise due to temperature fluctuations
convecting through turbine blade rows
[AIAA PAPER 75-528] A75-25791

- Preliminary experiments on film cooling of turbine
blades with injection near the leading edge. 1:
Injection through holes located near the leading
edge N75-17359

- [NAL-TR-371] N75-17359

TURBINE ENGINES

- The noise behaviour of aero engine turbine tones
[AIAA PAPER 75-466] A75-25742

TURBINE WHEELS

- Automatic balancing of rotors in high-speed machines
--- Russian book on turbomachines A75-23397

TURBOCOMPRESSORS

- Pressure increase in blade channels of axial-flow
compressors at low gas pressures A75-23099

- On stress in service condition and estimated
fatigue life of blades in axial flow compressor
A75-23152

- Analytic specification of compressor characteristics
A75-23816

- Calculation of flutter boundary of dynamically
nonuniform profile cascades A75-23819

- Compressor and turbine characteristic
representation in algorithm for calculating
turbojet engine throttling characteristics A75-23822

- The use of fiber-reinforced materials for
compressor blades A75-24159

- [DGLR PAPER 74-122] A75-24159

- Precision casting of aircraft and turbocompressor
parts by the method of melted out models A75-24828

TURBOFAN ENGINES

- Altitude evaluation of a variable cycle turbofan engine
[SAE PAPER 740806] A75-22938
- Impact response of graphite-epoxy flat laminates using projectiles that simulate aircraft engine encounters A75-25232
- Turbine noise generation, reduction and prediction [AIAA PAPER 75-449] A75-25731
- Effect of forward motion on fan noise [AIAA PAPER 75-464] A75-25740
- Acoustic characteristics of a large upper-surface blown configuration with turbofan engines [AIAA PAPER 75-473] A75-25748
- An experimental investigation of the core engine noise of a turbofan engine [AIAA PAPER 75-526] A75-25790
- Core engine noise due to temperature fluctuations convecting through turbine blade rows [AIAA PAPER 75-528] A75-25791
- Review of theory and methods for turbine noise prediction [AIAA PAPER 75-540] A75-25802
- Review of theory and methods for combustion noise prediction [AIAA PAPER 75-541] A75-25803
- FAA JT3D quiet nacelle retrofit feasibility program. Volume 3: Lower goal flight testing, economic analyses and summary [AD-787610] N75-17334
- Some questions on the creation of an open stand for acoustic investigations of DTRD's --- development of facilities for testing turbofan engines [AD-A000660] N75-17365
- Preliminary study of advanced turbofans for low energy consumption [NASA-TM-X-71663] N75-18241
- TURBOFANS**
- 'Ring vortex' energy losses during centrifugal fan operation in low output regimes A75-23806

TURBOJET ENGINES

- Compressor and turbine characteristic representation in algorithm for calculating turbojet engine throttling characteristics A75-23822
- Developmental programs for small expendable turbojets A75-24946
- Minimization of jet and core noise of a turbojet engine by swirling the exhaust flow [AIAA PAPER 75-503] A75-25769
- Cross-correlation of noise produced inside a hot turbojet exhaust with and without suppression using a new, hot probe [AIAA PAPER 75-505] A75-25771
- The effects of forward speed on a number of turbojet exhaust silencers [AIAA PAPER 75-506] A75-25772
- Near field noise prediction for a linear array of turbojet engines [AD-A001329] N75-18976

TURBOMACHINE BLADES

- Pressure increase in blade channels of axial-flow compressors at low gas pressures A75-23099
- Unsteady flow through a turbomachine stage with free vortex shed A75-23945
- Studies on the impact structural damage of composite blades A75-25240

TURBOMACHINERY

- The steady state and dynamic behaviour of the turbo-bearing A75-23615
- Averaging of nonuniform flow in turbomachine flow traverses A75-23821
- Experimental study of the unsteady flow through a turbomachine stage A75-23947
- Broadband noise generated by turbulent inflow to rotor or stator blades in an annular duct [NASA-CR-2503] N75-17361

TURBOPROP AIRCRAFT

- The Il-18 aircraft /2nd enlarged and revised edition/ --- Russian book A75-23421

TURBULENT BOUNDARY LAYER

- Calculation of turbulent shear stress in supersonic boundary-layer flows A75-23209
- Separation of turbulent boundary layer on a lifting cylinder A75-23223
- Studies of separated flows --- interaction of turbulent boundary layers with inviscid flow around transonic airfoils [AD-A000348] N75-17626
- Analytical study of ventilated wind tunnel boundary interference on V/STOL models including wake curvature and decay effects [NASA-CR-142240] N75-18188

TURBULENT FLOW

- Measurements of static inlet turbulence --- for turbofan engines [AIAA PAPER 75-467] A75-25743
- Noise radiation from turbulent flows over compliant surfaces [AIAA PAPER 75-507] A75-25773

TURBULENT WAKES

- Recent wake turbulence flight test programs A75-24805
- Turbulent wake behind slender bodies including self-propelled configurations [AD-A001040] N75-17319
- Flight test investigation of the vortex wake characteristics behind a Boeing 727 during two-segment and normal ILS approaches (A joint NASA/FAA report) [NASA-TM-X-62398] N75-17340
- The measurement of the McDonnell-Douglas DC-9 trailing vortex system using the tower fly-by technique [AD-A001456/3] N75-18222

TWO BODY PROBLEM

- Stationary reaction of a dual-sphere configuration moving in a free-molecular medium --- heat and energy transfer in rarefied gases [HEPT-36/1973] N75-18172

TWO DIMENSIONAL BODIES

- Entropy layer on a supersonic plane flat nose at incidence A75-23208

TWO DIMENSIONAL FLOW

- Unsteady flow through a turbomachine stage with free vortex shed A75-23945
- Review of integral-equation techniques for solving potential-flow problems with emphasis on the surface-source method A75-25120

- A prediction method for pressure distributions on compression surfaces of conical bodies at supersonic speeds --- delta wings, conical bodies, and two dimensional flow [ARC-CP-1295] N75-17307
- Stall flutter and nonlinear divergence of a two-dimensional flat plate wing [AD-A000569] N75-17314

- An analysis method for two-dimensional transonic viscous flow [NASA-TN-D-7718] N75-18179

TWO PHASE FLOW

- A limiting case of multiphase flow past slender bodies [AD-A000240] N75-17313

U**U-10 AIRCRAFT**

- Noise reduction studies for the U-10 airplane [NASA-TM-X-72640] N75-17360

UH-2 HELICOPTER

- Mechanical instability ground dynamics program [AD-A001101] N75-17349

ULTRASONIC WAVE TRANSDUCERS

- Nonintrusive ultrasonic measurement of flow velocity and mass flow rate A75-22880
- Ultrasonic flowmeter cell designs for liquids A75-25951

UNSTEADY FLOW

SUBJECT INDEX

UNSTEADY FLOW

- Unsteady flow through a turbomachine stage with free vortex shed A75-23945
- Experimental study of the unsteady flow through a turbomachine stage A75-23947
- UPGRADING
- Test bed for the upgraded third generation Air Traffic Control System A75-26064
- URBAN PLANNING
- Aircraft noise in a high-rise city A75-24000
- USER REQUIREMENTS
- An integrated PCM data system for full scale aeronautics testing --- common data bases for user requirements A75-23902

V

V/STOL AIRCRAFT

- RTOL and steep approach - Why [DGLR PAPER 74-112] A75-24152
- V/STOL rotor and propeller noise - Its prediction and analysis of its aural characteristics [AIAA PAPER 75-452] A75-25734
- The effect of ground proximity on the lateral/directional aerodynamic and control characteristics of a tilt-wing V/STOL aircraft at high lift coefficients [AD-A001584] N75-18227
- Acoustic transmission through a fuselage sidewall [NASA-CR-132602] N75-18971
- VACUUM MELTING
- Combining strength and fracture toughness --- vacuum arc melted steels for aerospace applications A75-24002
- VACUUM PUMPS
- Pressure increase in blade channels of axial-flow compressors at low gas pressures A75-23099
- VACUUM TESTS
- Investigation of the structure and properties of niobium in vacuum and in high-velocity air streams A75-23009
- VANES
- NASA vane alloy boasts high-temperature strength A75-24003
- VARIABLE GEOMETRY STRUCTURES
- Altitude evaluation of a variable cycle turbofan engine [SAE PAPER 740806] A75-22938
- The variable density aircraft concept A75-26010
- Measurement of the internal performance of a rectangular air intake mounted on a fuselage at Mach numbers from 1.6 to 2, part 4 [ARC-CP-1291] N75-17305
- VARIABLE SWEEP WINGS
- Wind tunnel investigations on an airplane model with variable sweepback in the incompressible region. Part 1: Comparison of the most important experimental parameters and their influence on the aerodynamic coefficients [IPD-4/73-PT-1] N75-17298
- VARIATIONAL PRINCIPLES
- Application of a variational method in plane compressible flow calculation --- steady inviscid plane subsonic flow past an airfoil [ARC-CP-1284] N75-17303
- VC-10 AIRCRAFT
- Study of solid state remote control techniques as applied to the redesign of the electrical system in a large civil aircraft [ARC-CP-1289] N75-17364
- Gust loads on 707 and VC 10 aircraft [ARC-CP-1281] N75-17373
- VELOCITY DISTRIBUTION
- Airship stresses due to vertical velocity gradients and atmospheric turbulence A75-25984
- VELOCITY MEASUREMENT
- Surveillance velocity measurements with least maximum error A75-25928

VERTICAL AIR CURRENTS

- Airship stresses due to vertical velocity gradients and atmospheric turbulence A75-25984

VERTICAL TAKEOFF AIRCRAFT

- A contribution to the problem of noise produced at the takeoff and landing of VTOL aircraft [DGLR PAPER 74-116] A75-24153
- Method of balancing VTOL aircraft [SAWE PAPER SWR 7] A75-24348
- Aerodynamics of the propellers of rapidly convertible VTOL aircraft A75-24942
- Multilevel control optimization using subsystem relative performance index sensitivity A75-25098
- VTOL flight-control system design using sensitivity analysis A75-25879
- Theoretical and experimental study on the ejector augmented jet flap [NASA-CR-136749] N75-17296
- An investigation of errors and data processing techniques for an RF multilateration system --- position and velocity measurements of vertical takeoff aircraft during landing [NASA-CR-132609] N75-17327
- VTOL airplane control in transition regimes [AD-A000128] N75-17378
- Report on program to improve MIL-F-83300 --- simulation of short takeoff aircraft longitudinal characteristics [AD-A001598] N75-18226
- VIBRATION ISOLATORS
- Analysis and design of a multiaxis vibration isolator for missile pods mounted on Army helicopters [AD-A001459] N75-18225
- VIBRATION MODE
- Fundamental frequency of a square panel with multiple point supports on edges A75-22798
- VISCOUS FLOW
- Hypersonic viscous slip flow over an insulated flat plate with real gas effects A75-23205
- An analysis method for two-dimensional transonic viscous flow [NASA-TN-D-7718] N75-18179
- VOLTERRA EQUATIONS
- The subsonic-supersonic analogy --- for flow around wing profiles A75-25459
- VORTEX RINGS
- 'Ring vortex' energy losses during centrifugal fan operation in low output regimes A75-23806
- VORTEX SHEETS
- The scattering of sound by a vortex sheet A75-22934
- Unsteady flow through a turbomachine stage with free vortex shed A75-23945
- VORTEX STREETS
- Flight test investigation of the vortex wake characteristics behind a Boeing 727 during two-segment and normal ILS approaches (A joint NASA/PAA report) [NASA-TN-X-62398] N75-17340
- VORTICES
- The structure and dynamics of vortex filaments --- in aircraft wakes A75-24481
- Recent wake turbulence flight test programs A75-24805
- Measurements of discrete vortex noise in a closed-throat wind tunnel [AIAA PAPER 75-488] A75-25758
- Influence of grazing flow on duct wall normal impedances --- for noise reduction [AIAA PAPER 75-494] A75-25763
- A model for the vortex pair associated with a jet in a cross flow [NASA-CR-136756] N75-17611
- The measurement of the McDonnell-Douglas DC-9 trailing vortex system using the tower fly-by technique [AD-A001456/3] N75-18222

W

- WAKES**
 Wake cutting by a cascade of cambered blades
 [AIAA PAPER 75-445] A75-25729
 The viscous flow around a two dimensional high lift wing. Analysis of boundary layer measurements
 [PFA-TN-AU-1155] N75-17310
- WALL FLOW**
 Influence of grazing flow on duct wall normal impedances --- for noise reduction
 [AIAA PAPER 75-494] A75-25763
- WAVE DIFFRACTION**
 The diffraction of a shock wave by a slender body
 A75-25458
- WAVE PROPAGATION**
 On the excess attenuation of sound in the atmosphere
 [NASA-TN-D-7823] N75-18030
- WEAR TESTS**
 Study of materials and nonmetallic coatings for erosion and wear resistance
 A75-23942
- WEDGE FLOW**
 Supersonic flow of a lightly dust-laden gas past a wedge
 A75-23298
- WEIGHT ANALYSIS**
 A solution to the transport of exceptionally large loads - The dirigible
 A75-23199
- WEIGHT REDUCTION**
 Fly-by-wire delta-canard configurations save weight
 [SAWE PAPER SWR 3] A75-24345
- WIND EFFECTS**
 Noncompact source effect on the prediction of tone noise from a fan rotor
 [AIAA PAPER 75-446] A75-25730
 An experimental simulation study of four crosswind landing gear concepts
 [NASA-TN-D-7864] N75-18184
- WIND TUNNEL CALIBRATION**
 The POF wind tunnel --- Field Observing Facility anemometer calibrations
 A75-24395
- WIND TUNNEL MODELS**
 The viscous flow around a two dimensional high lift wing. Analysis of boundary layer measurements
 [PFA-TN-AU-1155] N75-17310
 Wind tunnel investigation of the wake near the trailing edge of a distributed upper-surface-blown flap
 [NASA-TN-X-72637] N75-18176
 Effects of nozzle interfairing modifications on longitudinal aerodynamic characteristics of a twin jet, variable wing sweep fighter model
 [NASA-TN-D-7817] N75-18180
 Analytical study of ventilated wind tunnel boundary interference on V/STOL models including wake curvature and decay effects
 [NASA-CR-142240] N75-18188
 Airfoil optimization utilizing a remotely controlled flexible model. Phase 1: Low speed wind tunnel test
 [AD-A001094] N75-18189
 Wall corrections in transonic square test sections with perforated walls. Influence of the model span on lift corrections
 [AD-A000138] N75-18266
- WIND TUNNEL NOZZLES**
 Optimization of wind tunnel nozzles for the subsonic range
 A75-24271
- WIND TUNNEL STABILITY TESTS**
 The significance of aerodynamic jet interference in development and testing of the Do 31 V/STOL transport
 [NASA-TT-P-16165] N75-17335
- WIND TUNNEL TESTS**
 Investigation of the structure and properties of niobium in vacuum and in high-velocity air streams
 A75-23009
 Measured three-dimensional effects in transonic airfoil testing
 A75-23222
- Development and wind tunnel investigation of three supercritical airfoil profiles for transport aircraft
 [DGLR PAPER 74-100] A75-24147
 Recent progress in experimental studies of afterbodies
 A75-24943
- Wake cutting by a cascade of cambered blades
 [AIAA PAPER 75-445] A75-25729
 The development of experimental techniques for the study of helicopter rotor noise
 [AIAA PAPER 75-455] A75-25736
 Acoustic characteristics of a large upper-surface blown configuration with turbofan engines
 [AIAA PAPER 75-473] A75-25748
 Noise shielding effects for engine-over-wing installations
 [AIAA PAPER 75-474] A75-25749
 Forward velocity effects on under-the-wing externally blown flap noise
 [AIAA PAPER 75-476] A75-25750
 Measurements of discrete vortex noise in a closed-throat wind tunnel
 [AIAA PAPER 75-488] A75-25758
 Wind tunnel investigation of aerodynamic loads on a large-scale externally blown flap model and comparison with theory
 [NASA-TN-D-7863] N75-17294
 Theoretical and experimental study on the ejector augmented jet flap
 [NASA-CR-136749] N75-17296
 Wind tunnel investigations on an airplane model with variable sweepback in the incompressible region. Part 1: Comparison of the most important experimental parameters and their influence on the aerodynamic coefficients
 [IPD-4/73-PT-1] N75-17298
 Low-speed wind-tunnel tests on the lift-dependent drag of delta wings with conical camber
 [ARC-CP-1293] N75-17306
 Low speed wind tunnel test of jet flaps and floating wingtip ailerons on a fighter wing
 [AD-A000809] N75-17318
 Turbulent wake behind slender bodies including self-propelled configurations
 [AD-A001040] N75-17319
 Surface effect takeoff and landing system (SETOLS)
 [AD-A000101] N75-17345
 Transonic wind tunnel tests on two blunt trailing edge aerofoils
 [ARL/A-NOTE-351] N75-18175
 Static and wind tunnel model tests for the development of externally blown flap noise reduction techniques
 [NASA-CR-134675] N75-18177
- WIND VELOCITY MEASUREMENT**
 The POF wind tunnel --- Field Observing Facility anemometer calibrations
 A75-24395
- WINDSHIELDS**
 Proposed windshield for B-1 aircraft: An optical evaluation
 [AD-A001078] N75-17350
- WING FLAPS**
 Fluctuating pressures on aircraft wing and flap surfaces associated with powered-lift systems
 [AIAA PAPER 75-472] A75-25747
 Conversion factor for profile drag increment for part-span flaps
 [ESDU-FLAPS-02.01.07] N75-18173
- WING LOADING**
 Approximate solution to the wing theory equation by the Bubnov-Galerkin method
 A75-24833
- WING OSCILLATIONS**
 Finite element flutter analysis of multi-web wing structures
 A75-22795
 Fundamental frequency of a square panel with multiple point supports on edges
 A75-22798
- WING PLANFORMS**
 The effect of initial values on wing form and the limiting curve of the wave drag coefficients of optimized symmetrical-thick-delta wings in supersonic flow
 A75-23100

WING PROFILES

SUBJECT INDEX

Stall flutter and nonlinear divergence of a
two-dimensional flat plate wing
[AD-A000569] N75-17314

WING PROFILES

Analytic construction of function for conformal
transformation of exterior of circle onto
exterior of arbitrary wing profile
A75-23794

Transonic wing design and its effects on flight
performance
[DGLR PAPER 74-97] A75-24144

Development and wind tunnel investigation of three
supercritical airfoil profiles for transport
aircraft
[DGLR PAPER 74-100] A75-24147

The subsonic-supersonic analogy --- for flow
around wing profiles
A75-25459

WINGS

Approximate solution of integral equations with a
singular operator --- for wing motion
A75-24835

Y

YAW

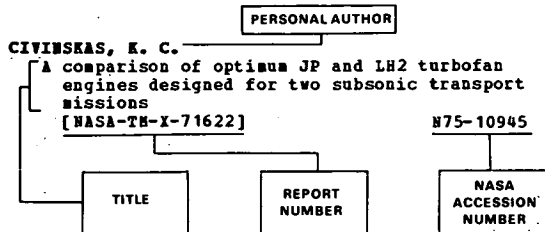
Evaluation of the effect of a yaw-rate damper on
the lateral-directional stability and control of
the Beechcraft Queen Air 80 laboratory aircraft
[NLR-TR-73105-U] N75-17374

PERSONAL AUTHOR INDEX

AERONAUTICAL ENGINEERING /A Special Bibliography (Suppl. 58)

JUNE 1975

Typical Personal Author Index Listing



Listings in this index are arranged alphabetically by personal author. The title of the document provides the user with a brief description of the subject matter. The report number helps to indicate the type of document cited (e.g., NASA report, translation, NASA contractor report). The accession number is located beneath and to the right of the title, e.g. N75-10945. Under any one author's name the accession numbers are arranged in sequence with the /AA accession numbers appearing first.

A

- ABKOWITZ, S.**
Cost savings in the application of P/M titanium and P/M aluminum alloys
A75-23412
- ABRAHAMSON, A. L.**
Propagation of aircraft noise over long distances through the lower atmosphere
[AIAA PAPER 75-542]
A75-25804
- ACHIN, H.**
Results of the investigation regarding two three-dimensional low-level flight control systems
[DGLR PAPER 74-83]
A75-24139
- APRICK, S.**
Prediction of airframe noise
[NASA-TN-D-7821]
N75-18182
- APRICK, S. A.**
Diagnostic calculations of airframe-radiated noise
[AIAA PAPER 75-485]
A75-25755
- AKHMEDEYANOV, A. M.**
Analytic specification of compressor characteristics
A75-23816
- AKINDEEV, A. E.**
Handbook for aircraft mechanics /3rd revised and enlarged edition/
A75-23366
- ALFORD, W. J., JR.**
Future long-range transports: Prospects for improved fuel efficiency
[NASA-TN-X-72659]
N75-17339
- ALIEV, R. E.**
Laboratory evaluation of the stability of high-purity jet fuels of the T-8 type and of the effectiveness of antioxidants
A75-24274
- ALTHAN, H. B.**
Corporate/executive aircraft passenger safety - An educational approach
A75-25874
- ALYEA, F. H.**
First results of a general circulation model applied to the SST-NOX problem
A75-23982
- AMBOS, H.**
Aerospace technology - Planning methodology and defense-technological objectives
[DGLR PAPER 74-67]
A75-24130
- ANDERSON, D.**
Numerical solutions for supersonic corner flow
A75-23295

- ANDERSON, K. W.**
Manual control system design using a dual suboptimal control model
A75-24839
- ANDERSON, H. R.**
YP-16 flight test program - Lightweight fighter program
A75-24808
- ANDERSON, R. C.**
Design analysis of helicopter automatic and semiautomatic airborne precision pointing and tracking systems
[AD-A000834]
N75-18229
- ANTIPENKO, I. M.**
Exploitation of air conditioning systems for passenger aircraft
A75-23375
- ARAVANUDAN, K.**
Stall flutter and nonlinear divergence of a two-dimensional flat plate wing
[AD-A000569]
N75-17314
- ARCHER, R. D.**
Entropy layer on a supersonic plane flat nose at incidence
A75-23208
- ARDEHA, H. D.**
Preliminary estimates of operating costs for lighter than air transports
A75-25972
- ARNBRUSTER, M.**
Study of materials and nonmetallic coatings for erosion and wear resistance
A75-23942
- ARNSTRONG, R. S.**
Recent advances in exhaust systems for jet noise suppression of high speed aircraft
[AIAA PAPER 75-333]
A75-25016
- ARNOLD, W. R.**
Sparse matrix techniques applied to modal analysis of multi-section duct liners
[AIAA PAPER 75-514]
A75-25780
- ASHBY, G. C., JR.**
Aerodynamic testing technique for twin fuselage models at hypersonic speeds
[NASA-TN-X-3196]
N75-18187
- ASHTON, J. E.**
Trends in aerospace vehicle design
[SAWE PAPER SWR 4]
A75-24346
- ATVARS, J.**
Recent advances in exhaust systems for jet noise suppression of high speed aircraft
[AIAA PAPER 75-333]
A75-25016
- AUSROTAS, R. A.**
Basic relationships for LTA economic analysis
A75-25971
Basic relationships for LTA technical analysis
A75-25981
- AVERY, J. G.**
Comparisons of the ballistic impact response of metals and composites for military aircraft applications
A75-25230

B

- BAIRNSPATHER, R. R.**
Man-rated flight software for the P-8 DFBW program
N75-18250
- BALLENGER, D. W.**
Experimental determination of the separation point of flow around a circular cylinder
A75-22868

- BALLEYGUIER, M. A.
A practical concept for powered or tethered weight-lifting LTA vehicles
A75-26022
- BALNAKOV, A. I.
Some questions on the creation of an open stand for acoustic investigations of DTRD's [AD-A000660]
N75-17365
- BARANOV, A. M.
Static structural test for supersonic aircraft
A75-23233
- BARBER, M. R.
Recent wake turbulence flight test programs
A75-24805
- Flight test investigation of the vortex wake characteristics behind a Boeing 727 during two-segment and normal ILS approaches (A joint NASA/FAA report) [NASA-TN-X-62398]
N75-17340
- BARNETT, L.
Application of the equivalent mechanical flap concept to jet flapped wing-body combinations [AD-A000431]
N75-17346
- BARRA, V.
Ambient and induced pressure fluctuations in supersonic jet flows [AIAA PAPER 75-482]
A75-25754
- BASKARAN, S.
Propagation of sound in elliptic ducts
A75-22791
- BATH, A. K.
Evaluation of stiffness coefficients for fiber-reinforced laminated composites
A75-23667
- BATTERTON, P. G.
Digital implementation of the TF30-P-3 turbofan engine control [NASA-TN-X-3105]
N75-18239
- BAUER, F.
Supercritical wing sections 2, volume 108 [NASA-CR-142229]
N75-18167
- BAUMEISTER, K. J.
Generalized wave envelope analysis of sound propagation in ducts with stepped noise source profiles and variable axial impedance [AIAA PAPER 75-518]
A75-25784
- BAVITZ, P. C.
An analysis method for two-dimensional transonic viscous flow [NASA-TN-D-7718]
N75-18179
- BAXI, C. B.
A model for rain erosion of homogeneous materials
A75-25185
- BAYNTON, H. W.
The FOF wind tunnel
A75-24395
- BEAVIN, R. C.
Measurement of advanced composition materials shielding effectiveness [AD-A000414]
N75-17425
- BECKENMEYER, E. J.
Computational methods for acoustic radiation from circular ducts [AIAA PAPER 75-516]
A75-25782
- Effects of a conical segment on sound radiation from a circular duct [AIAA PAPER 75-517]
A75-25783
- BECKNANN, M.
Supercritical wing sections 2, volume 108 [NASA-CR-142229]
N75-18167
- BELOZEROV, L. G.
Static structural test for supersonic aircraft
A75-23233
- BENNER, W.
Problems and implementation possibilities of a direct side force control in the case of fighters [DGLR PAPER 74-84]
A75-24140
- BENNETT, D. H.
F-4/CCV-flight tests of advanced technology [SAE PAPER 740861]
A75-22940
- BENNETT, J.
The steady state and dynamic behaviour of the turbo-bearing
A75-23615
- BERNARD, H.
Study of materials and nonmetallic coatings for erosion and wear resistance
A75-23942
- BERNI, A. J.
Target identification by natural resonance estimation
A75-25878
- BERTLEUD, A.
The viscous flow around a two dimensional high lift wing. Analysis of boundary layer measurements [FFA-TN-AU-1155]
N75-17310
- BETTERIDGE, D. S.
Entropy layer on a supersonic plane flat nose at incidence
A75-23208
- BIAGLOW, J. A.
Idle efficiency and pollution results for two-row swirl-can combustors having 72 modules [NASA-TN-X-3208]
N75-18240
- BLACK, R. E.
Advanced subsonic transports - a challenge for the 1990's [AIAA PAPER 75-304]
A75-23251
- BLANTON, J. M.
An investigation of rooftop STOL port aerodynamics [NASA-CR-132570]
N75-17381
- BLISS, D. B.
Diagnostic calculations of airframe-radiated noise [AIAA PAPER 75-485]
A75-25755
- BLOCK, P. J.
Airframe noise measurements on a transport model in a quiet flow facility [AIAA PAPER 75-509]
A75-25775
- BLOETSCHER, F.
Effect of present technology on airship capabilities
A75-25974
- BLOOM, A. M.
Wind tunnel investigation of the wake near the trailing edge of a distributed upper-surface-blown flap [NASA-TN-X-72637]
N75-18176
- BOCHE, R.
The Alpha-Jet spoiler of carbon-epoxy material [DGLR PAPER 74-119]
A75-24156
- BODENBER, A.
Developmental programs for small expendable turbojets
A75-24946
- BOEHM, H.
Observations on the construction and use of airplane hangars
A75-23046
- BOERGER, G.-G.
Optimization of wind tunnel nozzles for the subsonic range
A75-24271
- BOGACHEV, I. M.
Investigation of the structure and properties of niobium in vacuum and in high-velocity air streams
A75-23009
- BOGOMOLOV, E. M.
Thermodynamics of multistage air-cooled gas turbine
A75-23817
- BOLTE, J.
Maintenance overhauls performed according to an overhaul schedule
A75-23044
- BORISOV, I. V.
Aircraft switching devices: Fabrication technology and installation
A75-23369
- BORK, P.
Connection between the flight plan and the repair hangar control plan and its meaning for the quality of the transport process
A75-23043
- BOURGOIS, A.
The use of titanium and its alloys in the manufacture of helicopters and aircraft structures [BR44857]
N75-17337
- BOUTES, J.
A solution to the transport of exceptionally large loads - The dirigible
A75-23199
- BOYKIN, W. H.
Design analysis of helicopter automatic and semiautomatic airborne precision pointing and tracking systems [AD-A000834]
N75-18229

- BRADSHAW, J. H.**
Nonintrusive ultrasonic measurement of flow velocity and mass flow rate A75-22880
- BRAGA, V. G.**
Handbook for aircraft mechanics /3rd revised and enlarged edition/ A75-23366
- BREITBACH, E.**
Aircraft flutter simulation by means of the electronic analogue computer with special regard to structural nonlinearities [ESRO-TT-121] N75-17384
- BREWER, G. D.**
Study of active cooling for supersonic transports [NASA-CR-132573] N75-17336
- BRIANCON, R.**
Design of low-pollution burners A75-24945
- BRITT, C. L., JR.**
An investigation of errors and data processing techniques for an RF multilateration system [NASA-CR-132609] N75-17327
- BROOKS, J. R.**
The effects of forward speed on a number of turbojet exhaust silencers [AIAA PAPER 75-506] A75-25772
- BROWN, B.**
Development of a non-survey method estimating traffic at nontowered airports [AD-A002397] N75-18263
- BROWN, C. S.**
Measurement of the internal performance of a rectangular air intake mounted on a fuselage at Mach numbers from 1.6 to 2, part 4 [ARC-CP-1291] N75-17305
- BROWN, G. J.**
Remotely piloted LTA vehicle for surveillance A75-26028
- BROWN, J. S.**
'LOTS' of LTA applications A75-26027
- BRYANT, W. H.**
Monte Carlo analysis of inaccuracies in estimated aircraft parameters caused by unmodeled flight instrumentation errors [NASA-TN-D-7712] N75-17368
- BULLOCK, T. E.**
Design analysis of helicopter automatic and semiautomatic airborne precision pointing and tracking systems [AD-A000834] N75-18229
- BURGAN, E. T.**
Surface effect takeoff and landing system (SETOLS) [AD-A000101] N75-17345
- BURKLUND, V. D.**
Electrostatic vertical sensing and control concept for aircraft escape systems A75-25068
- BUSHELL, K. W.**
Measurement and prediction of jet noise in flight [AIAA PAPER 75-461] A75-25738
- BUTTERWORTH, P. J.**
Low-speed wind-tunnel tests on the lift-dependent drag of delta wings with conical camber [ARC-CP-1293] N75-17306
- BYRDSONG, T. A.**
An experimental simulation study of four crosswind landing gear concepts [NASA-TN-D-7864] N75-18184
- C**
- CADDELL, W. E.**
Fly-by-wire delta-canard configurations save weight [SAWE PAPER SWR 3] A75-24345
- CAWSDALE, R.**
An aeroelastic model helicopter rotor [ARC-CP-1288] N75-17304
- CARLOCK, G. W.**
VTOL flight-control system design using sensitivity analysis A75-25879
- CARR, D. L.**
Effect of geometry on open cavity flow-induced pressure oscillations [AIAA PAPER 75-492] A75-25761
- CARSON, B. E.**
An economic comparison of three heavy lift airborne systems A75-25978
- CARTLEDGE, L.**
Advanced signal processing for airport surveillance radars A75-26037
- CHALK, C. R.**
Report on program to improve MIL-F-83300 [AD-A001598] N75-18226
- CHAMIS, C. C.**
Structural response of a fiber composite compressor fan blade airfoil [NASA-TN-X-71623] N75-17709
- CHAN, K. L.**
Measurements of supersonic jet aircraft wakes in the stratosphere A75-23962
- CHANDRAKER, A. L.**
Generalized aerodynamic noise equation A75-24418
- CHEN, C. F.**
Experimental determination of the separation point of flow around a circular cylinder A75-22868
- CHILDS, J. T.**
Emergency and disaster plans, and associated problems concerning major aircraft accidents A75-25069
- CHILDS, M. E.**
Calculation of turbulent shear stress in supersonic boundary-layer flows A75-23209
- CHORLEY, R. A.**
Head-up and other displays A75-24050
- CHOU, D. C.**
Aerodynamic heating of supersonic blunt bodies [AD-A001135] N75-18190
- CHOUTEAU, H. E.**
XF-17 flight test program - Lightweight fighter program A75-24809
- CHUBBUCK, E. R.**
Analysis and design of a multiaxis vibration isolator for missile pods mounted on Army helicopters [AD-A001459] N75-18225
- CHUN, C. H.**
Pressure increase in blade channels of axial-flow compressors at low gas pressures A75-23099
- CLAREUS, U.**
Ice simulation: A 2-dimensional wind tunnel investigation of a NACA 652A215 wing section with single slotted flap. Part 2: Configurations typical for transport airplanes [FFA-TN-AU-995-PT-2] N75-17309
- CLARK, L. R.**
Noise characteristics of the O-1 airplane and some approaches to noise reduction [NASA-TN-X-72638] N75-18233
- CLARK, W. E., JR.**
Helicopter TERPS validation study, phase 1 [AD-A000423] N75-17347
- CLAY, C. W.**
The shape of the future long-haul transport airplane [AIAA PAPER 75-305] A75-25012
- COAKLEY, J. A., JR.**
Possible climatic effects of supersonic transports A75-23973
- COCHRANE, J.**
Concorde inlet system and peripheral envelope flight testing A75-24804
- COLEMAN, R. G.**
Aerodynamic design and analysis system for supersonic aircraft. Part 3: Computer program description [NASA-CR-2522] N75-18186
- CONEN, H.**
The Alpha-Jet spoiler of carbon-epoxy material [DGLR PAPER 74-119] A75-24156
- CONN, A. F.**
Effects of fatigue and dynamic recovery on rain erosion A75-25189

- CONNOR, A. B.
Noise reduction studies for the U-10 airplane
[NASA-TN-X-72640] N75-17360
Noise reduction studies for the Cessna model 337
(0-2) airplane
[NASA-TN-X-72641] N75-18231
Noise reduction studies for the OV-1 airplane
[NASA-TN-X-72639] N75-18232
Noise characteristics of the O-1 airplane and some
approaches to noise reduction
[NASA-TN-X-72638] N75-18233
Noise reduction studies of several aircraft to
reduce their aural detection distances
[NASA-TN-X-72644] N75-18235
A noise study of the A-6 airplane and techniques
for reducing its aural detection distance
[NASA-TN-X-72643] N75-18236
- CONTI, R. J.
Measurements of supersonic jet aircraft wakes in
the stratosphere
A75-23962
- CONTICELLI, V. H.
Noise shielding effects for engine-over-wing
installations
[AIAA PAPER 75-474] A75-25749
- COOK, T. S.
Impact response of graphite-epoxy flat laminates
using projectiles that simulate aircraft engine
encounters
A75-25232
- COOPER, J. L.
A curve fitting method for solving the flutter
equation
[NASA-CR-132629] N75-17341
- COPELAND, W. L.
Noise reduction studies for the OV-1 airplane
[NASA-TN-X-72639] N75-18232
Noise characteristics of the O-1 airplane and some
approaches to noise reduction
[NASA-TN-X-72638] N75-18233
- CORNIGLIONE, J.
Unsteady flow through a turbomachine stage with
free vortex shed
A75-23945
Experimental study of the unsteady flow through a
turbomachine stage
A75-23947
- COTTON, L. S.
Three-axis fluidic/electronic automatic flight
control system flight test report
[AD-A000894] N75-17379
- COUGHLIN, S.
The application of the airship to regions lacking
in transport infrastructure
A75-26012
- COULMY, G.
Calculation by the singularity method of the
characteristics of a cascade in compressible
flow without knocking up to the supercritical
speed
A75-23988
- CRAFT, J. B.
The effects of lightning on digital flight control
systems
N75-18249
- CROCKER, H. J.
Noise legislation and regulations
A75-23436
- CROWLEY, L. D.
Evolution of the Douglas flight-test data system
A75-23888
- CULHANE, L. G.
Ground-based collision avoidance systems for air
traffic
A75-26062
- CUNHOLD, D. H.
First results of a general circulation model
applied to the SST-MOx problem
A75-23982
- CURRIE, G. H.
Forecasting traffic in an air transport network
A75-24341
- CURTISS, H. C., JR.
The effect of ground proximity on the
lateral/directional aerodynamic and control
characteristics of a tilt-wing V/STOL aircraft
at high lift coefficients
[AD-A001584] N75-18227
- CHYNAR, D. S.
Digital implementation of the TF30-P-3 turbofan
engine control
[NASA-TN-X-3105] N75-18239
- D**
- DAVILOV, N. V.
Exploitation of air conditioning systems for
passenger aircraft
A75-23375
- DAUGARD, S. J.
Effect of drag-reducing polymer injection on the
lift and drag of a two-dimensional hydrofoil
[AD-A000262] N75-17624
- DAVENPORT, A. C.
The variable density aircraft concept
A75-26010
- DAVENPORT, W. R.
Altitude evaluation of a variable cycle turbofan
engine
[SAE PAPER 740806] A75-22938
- DAVIS, S. J.
Documenting helicopter operations from an energy
standpoint
[NASA-CR-132578] N75-18220
- DAVIS, S. S.
Measurements of discrete vortex noise in a
closed-throat wind tunnel
[AIAA PAPER 75-488] A75-25758
- DE CORLIEU, G.
Data transmission by optical fibers aboard aircraft
A75-23855
- DECOUPLET, J.
Design of low-pollution burners
A75-24945
- DEETS, D. A.
Design and development experience with a digital
fly-by-wire control system in an F-8C airplane
N75-18247
- DEFIORE, T. A.
Statistical review of counting accelerometer data
for Navy and Marine fleet aircraft
[AD-A000092] N75-17355
- DELOACH, R.
On the excess attenuation of sound in the atmosphere
[NASA-TN-D-7823] N75-18030
- DEMENTEVA, G. P.
Analysis of frequency error of airplane descent
rate measured by a laser
A75-23797
- DENKE, P. H.
Matrix difference equation analysis of vibrating
periodic structures
A75-23201
- DEREVENKO, V. A.
Study of annular nozzle cascades with different
'reverse' vane twist
A75-23818
- DEVEREAUX, R. L.
Flight test investigation of the vortex wake
characteristics behind a Boeing 727 during
two-segment and normal ILS approaches (A joint
NASA/FAA report)
[NASA-TN-X-62398] N75-17340
- DI BLASI, A.
Noise shielding effects for engine-over-wing
installations
[AIAA PAPER 75-474] A75-25749
- DIBBLE, A. C., JR.
Noise reduction studies for the OV-1 airplane
[NASA-TN-X-72639] N75-18232
- DICKER, R. W.
Forecasting traffic in an air transport network
A75-24341
- DINGELDEIN, R. C.
Noise reduction studies for the U-10 airplane
[NASA-TN-X-72640] N75-17360
Noise reduction studies for the Cessna model 337
(0-2) airplane
[NASA-TN-X-72641] N75-18231
Noise reduction studies of several aircraft to
reduce their aural detection distances
[NASA-TN-X-72644] N75-18235
- DORTSCH, K. H., JR.
The flight investigation and analysis of
longitudinal handling qualities of STOL aircraft
on landing approach
[AD-A001596] N75-18254

- DONE, G. T. S.
The response of a vibrating structure as a function of structural parameters
A75-22796
- DOOLITTLE, D. B.
Aerocrane - A hybrid LTA aircraft for aerial crane applications
A75-26019
- DORSCH, R.
Forward velocity effects on under-the-wing externally blown flap noise
[AIAA PAPER 75-476]
A75-25750
- DOVZHENKO, N. V.
Calculation of flutter boundary of dynamically nonuniform profile cascades
A75-23819
- DOWELL, E. H.
Aeroelasticity of plates and shells
A75-25180
- DOWIE, C. S.
Stratospheric pollution - Aircraft engine emissions in the region above the tropopause as a function of aircraft altitude and tropopause height
A75-23965
- DROUILHET, P. R.
DABS - Projected performance and experimental results
A75-26061
- DRURY, W. H.
Advanced signal processing for airport surveillance radars
A75-26037
- DUBRO, G. A.
Measurement of advanced composition materials shielding effectiveness
[AD-A000414]
N75-17425
- DUCLOS, R.
Forecasting traffic in an air transport network
A75-24341
- DUGAN, J. P., JR.
Future long-range transports: Prospects for improved fuel efficiency
[NASA-TM-X-72659]
N75-17339
- DUGUNDJI, J.
Stall flutter and nonlinear divergence of a two-dimensional flat plate wing
[AD-A000569]
N75-17314
- DUNCAN, J. L.
Long fluid filled bags suspended by line forces
A75-25988
The design and construction of the CAD-1 airship
A75-26002
- DUNEGAN, H. L.
Practical applications of acoustic emission
A75-24461
- DYN, C. L.
Stability theory and its applications to structural mechanics
A75-25181
- DZISHKARIANI, A. V.
Approximate solution of integral equations with a singular operator
A75-24835
- E**
- EBERLE, A.
Transonic profile design
[DGLR PAPER 74-98]
A75-24145
- EGGSPUEHLER, J. J.
General aviation safety - Fact and fiction
A75-25719
- EHM, G.
Transonic wind tunnel tests on two-dimensional aerofoil sections Part 1: Determination of pressure distribution and drag for an aerofoil of type NLR 13 in FFA wind tunnel S5
[FFA-TM-AU-725-PT-1]
N75-17299
- EIDE, G. R.
Matrix difference equation analysis of vibrating periodic structures
A75-23201
- EMMERLING, J. J.
Review of theory and methods for combustion noise prediction
[AIAA PAPER 75-541]
A75-25803
- ENENKOV, V. G.
Some questions on the creation of an open stand for acoustic investigations of DTRD's
[AD-A000660]
N75-17365
- ENEY, J. A.
Low speed wind tunnel test of jet flaps and floating wingtip ailerons on a fighter wing
[AD-A000809]
N75-17318
- ENGELKEN, E. J.
A laser-generated visual display and tracking task for a link GAT-1 flight trainer
[AD-A001079]
N75-17391
- ENGLIN, B. A.
Laboratory evaluation of the stability of high-purity jet fuels of the T-8 type and of the effectiveness of antioxidants
A75-24274
- ERKELENS, L. J.
Evaluation of the effect of a yaw-rate damper on the lateral-directional stability and control of the Beechcraft Queen Air 80 laboratory aircraft
[NLR-TR-73105-U]
N75-17374
- F**
- FARASSAT, F.
Thickness noise of helicopter rotors at high tip speeds
[AIAA PAPER 75-453]
A75-25735
- FARLOW, H. H.
Measurements of supersonic jet aircraft wakes in the stratosphere
A75-23962
- FEDERMAN, P. J.
Survey of thin film fluorescent material
[AD-A005571]
N75-18194
- FEIR, J. B.
Evaluation of routing and scheduling considerations for possible future commercial hypersonic transport aircraft
[NASA-CR-132632]
N75-18193
- FERRI, A.
Pre vaporization and premixing to obtain low oxides of nitrogen in gas turbine combustors
[NASA-CR-2495]
N75-17362
- FESSENDEN, R.
Vertical seeking ejection seat
A75-25053
- FETHNEY, P.
An experimental study of airframe self-noise
[AIAA PAPER 75-511]
A75-25777
- FIEBIG, M.
Low Reynolds number hypersonic nozzle flows
A75-24270
- FINK, H. B.
Scrubbing noise of externally blown flaps
[AIAA PAPER 75-469]
A75-25745
- FLEMMING, M.
Development and use of types of construction employing fiber-reinforced materials
[DGLR PAPER 14-117]
A75-24154
- FLETCHER, J. J.
The noise behaviour of aero engine turbine tones
[AIAA PAPER 75-466]
A75-25742
- FOGY, M.
SLAR, its principles of operation and requirements regarding the positional stability of carrier platforms
A75-25697
- FORD, T. E.
Fuelling systems
A75-25275
- FOREMAN, K. E.
Simulation of hypersonic scramjet exhaust
[NASA-CR-2494]
N75-17344
- FORSYTH, D. R.
Wind tunnel investigation of the wake near the trailing edge of a distributed upper-surface-blown flap
[NASA-TM-X-72637]
N75-18176
- FRAGA, D. E.
AFTI TI-1 program
[SAE PAPER 740860]
A75-22939
- FRANKE, H. E.
Effect of geometry on open cavity flow-induced pressure oscillations
[AIAA PAPER 75-492]
A75-25761

FRANKE, W.

- Problems in the integration of infrared line
scanners in high-performance aircraft
[DGLR PAPER 74-94] A75-24143

FRATELLO, D. J.

- Acoustic characteristics of a large upper-surface
blown configuration with turbofan engines
[AIAA PAPER 75-473] A75-25748

- A preliminary investigation of remotely piloted
vehicles for airframe noise research
[AIAA PAPER 75-512] A75-25778

- Prediction of airframe noise
[NASA-TN-D-7821] N75-18182

FRAZZINI, R.

- Analysis and preliminary design of an advanced
technology transport flight control system
[NASA-CR-2490] N75-17295

FRETCH, J. C.

- NASA vane alloy boasts high-temperature strength
A75-24003

FROMAN, D. A.

- Effect of drag-reducing polymer injection on the
lift and drag of a two-dimensional hydrofoil
[AD-A000262] N75-17624

G

GABEDOVA, T. V.

- Approximate solution to the wing theory equation
by the Bubnov-Galerkin method
A75-24833

GAMON, H. A.

- Experimentally verified analytical techniques for
predicting vehicle crash response
[AIAA PAPER 75-273] A75-25006

GARABEDIAN, P.

- Supercritical wing sections 2, volume 108
[NASA-CR-142229] N75-18167

GARNATZ, P.

- Development of the inlet ramp of a supersonic
aircraft, employing a design which utilizes a
fiber composite material
[DGLR PAPER 74-120] A75-24157

GARNER, P.

- Computational methods for acoustic radiation from
circular ducts
[AIAA PAPER 75-516] A75-25782
- Effects of a conical segment on sound radiation
from a circular duct
[AIAA PAPER 75-517] A75-25783

GARODZ, L. J.

- Flight test investigation of the vortex wake
characteristics behind a Boeing 727 during
two-segment and normal ILS approaches (A joint
NASA/FAA report)
[NASA-TM-X-62398] N75-17340
- The measurement of the McDonnell-Douglas DC-9
trailing vortex system using the tower fly-by
technique
[AD-A001456/3] N75-18222

GARRISON, C. P.

- F-15 update report
A75-24806

GAVRILOV, A. S.

- Analytic specification of compressor characteristics
A75-23816

GEORGE, D. H.

- Evaluation of a Sperry Lidar Ceilometer
[AD-777820] N75-17653

GEYER, G. B.

- Evaluation of a high-capacity, firefighting
foam-dispensing system
[AD-A006264] N75-18259

GIBBONS, R. C.

- Study of alternative beacon based surveillance and
data link systems, volume 2
[AD-772136] N75-17325

GIBSON, J. S.

- Methods for the prediction of airframe aerodynamic
noise
[AIAA PAPER 75-539] A75-25801

GILARSKI, W.

- Precision casting of aircraft and turbocompressor
parts by the method of melted out models
A75-24828

GOLDHAMMER, M. I.

- Methods for predicting the aerodynamic and
stability and control characteristics of STOL
aircraft. Volume 1: Basic theoretical methods
[AD-A001580] N75-17375

- Methods for predicting the aerodynamic and
stability and control characteristics of STOL
aircraft. Volume 2: STOL aerodynamic methods
computer program
[AD-A001581] N75-17376

- Methods for predicting the aerodynamic and
stability and control characteristics of STOL
aircraft. Volume 3: Engineering methods
[AD-A001582] N75-17377

GOLDSNITH, E. L.

- Measurement of the internal performance of a
rectangular air intake mounted on a fuselage at
Mach numbers from 1.6 to 2, part 4
[ARC-CP-1291] N75-17305

GOLDSWORTHY, W. B.

- N/C tape laying - Tomorrow's future today
[SME PAPER MS74-729] A75-23441

GOBIODSKII, V. I.

- Aircraft control surface actuators
A75-23423

GOOD, R. C.

- Effect of forward motion on fan noise
[AIAA PAPER 75-464] A75-25740

GOODYKOONTZ, J.

- Forward velocity effects on under-the-wing
externally blown flap noise
[AIAA PAPER 75-476] A75-25750

GRAHAM, D. K.

- A procedure for the design of multifunction
switching controls
[AD-A000532] N75-17354

GREENE, G. C.

- Wind tunnel investigation of aerodynamic loads on
a large-scale externally blown flap model and
comparison with theory
[NASA-TN-D-7863] N75-17294

GREENHAIGH, S.

- Low speed wind tunnel test of jet flaps and
floating wingtip ailerons on a fighter wing
[AD-A000809] N75-17318

GRISSA, A.

- Calculation by the singularity method of the
characteristics of a cascade in compressible
flow without knocking up to the supercritical
speed
A75-23988

GUBEROV, KH. S.

- Analytic specification of compressor characteristics
A75-23816

GUPTA, N. K.

- Input design for identification of aircraft
stability and control derivatives
[NASA-CR-2493] N75-17370

H

HAAS, R. L.

- . AFTI TI-1 program
[SAE PAPER 740860] A75-22939

HACKNEY, L. R.

- Airship logistics - The LTA vehicle, a total cargo
system
A75-26015

HAESEVOETS, C.

- Experimental study of a two pressure stage air
cushion
[NT-36] N75-18174

HALL, W. E., JR.

- Input design for identification of aircraft
stability and control derivatives
[NASA-CR-2493] N75-17370

HALLOCK, J. N.

- Status of the wake vortex avoidance system
A75-26060

HAMILTON, R. H.

- Surveillance velocity measurements with least
maximum error
A75-25928

HAMMITT, A. G.

- The aerodynamics of vehicles in finite length tubes
[PB-236692/0] N75-18192

- HANAWA, T.
On the natural vibration of plate-beam combination
structures, 4
[NAL-TR-363] N75-17707
- HANSON, D. B.
Measurements of static inlet turbulence
[AIAA PAPER 75-467] A75-25743
A study of subsonic fan noise sources
[AIAA PAPER 75-468] A75-25744
- HARDIN, J. C.
Prediction of airframe noise
[NASA-TN-D-7821] N75-18182
- HARPER, M.
A semibuoyant vehicle for general transportation
missions A75-26006
- HARPULA, S.
Precision casting of aircraft and turbocompressor
parts by the method of melted out models A75-24828
- HARRIS, G. L.
Remotely piloted LTA vehicle for surveillance
A75-26028
- HARRIS, W. L.
The development of experimental techniques for the
study of helicopter rotor noise
[AIAA PAPER 75-455] A75-25736
- HARTHOORN, R.
Comparative airship economics A75-25973
- HARTMANN, U.
Control and program technology for the
implementation of digital flight control systems
[DGLR PAPER 74-81] A75-24138
- HAVILAND, R. P.
Aero-marine communications by satellite
A75-24100
- HAVILL, C. D.
A semibuoyant vehicle for general transportation
missions A75-26006
- HAWKES, T. A.
Data transmission by optical fibers aboard aircraft
A75-23855
- HAWKINGS, D. L.
Noise of high speed rotors
[AIAA PAPER 75-450] A75-25732
- HAYDEN, R. E.
Diagnostic calculations of airframe-radiated noise
[AIAA PAPER 75-485] A75-25755
Prediction of airframe noise
[NASA-TN-D-7821] N75-18182
- HEALY, G. J.
Aircraft far-field aerodynamic noise - Its
measurement and prediction
[AIAA PAPER 75-486] A75-25756
Methods for the prediction of airframe aerodynamic
noise
[AIAA PAPER 75-539] A75-25801
- HELLMAN, T. H.
Miniature probe for transonic flow direction
measurements A75-23224
- HEMP, G. W.
Design analysis of helicopter automatic and
semiautomatic airborne precision pointing and
tracking systems
[AD-A000834] N75-18229
- HENDERSON, H. R.
Ground noise measurements during static and flyby
operations of the Cessna 02-T turbine powered
airplane
[NASA-TM-X-72642] N75-18234
- HENRIKSSON, K.-E.
Report on spin test of AJ37 Viggen
A75-24807
- HENRY, P. H.
A laser-generated visual display and tracking task
for a link GAT-1 flight trainer
[AD-A001079] N75-17391
- HENZE, E.
Static computation of a wing model made of carbon
fiber reinforced plastic /bending-torsion box/
with the aid of the method of finite elements
and a comparison with experimental values
[DGLR PAPER 74-118] A75-24155
The Alpha-Jet spoiler of carbon-epoxy material
[DGLR PAPER 74-119] A75-24156
- HERBST, W.
Development trends in aircraft design
[DGLR PAPER 74-68] A75-24131
- HERNANDEZ RAPOSO, J.
Air traffic control A75-25861
- HESS, J. L.
Review of integral-equation techniques for solving
potential-flow problems with emphasis on the
surface-source method A75-25120
- HEYS, H.
Application of a variational method in plane
compressible flow calculation
[ARC-CP-1284] N75-17303
- HICKS, R. M.
Application of numerical optimization to the
design of low speed airfoils
[NASA-TM-X-3213] N75-18181
- HILBIG, R.
Contribution to the study of supercritical profile
flow
[DGLR PAPER 74-99] A75-24146
- HILDEBRAND, G.
Vertical seeking ejection seat A75-25053
- HILTON, D. A.
Thickness noise of helicopter rotors at high tip
speeds
[AIAA PAPER 75-453] A75-25735
Noise reduction studies for the U-10 airplane
[NASA-TM-X-72640] N75-17360
Noise reduction studies for the Cessna model 337
(0-2) airplane
[NASA-TM-X-72641] N75-18231
Noise reduction studies for the OV-1 airplane
[NASA-TM-X-72639] N75-18232
Noise characteristics of the O-1 airplane and some
approaches to noise reduction
[NASA-TM-X-72638] N75-18233
Ground noise measurements during static and flyby
operations of the Cessna 02-T turbine powered
airplane
[NASA-TM-X-72642] N75-18234
Noise reduction studies of several aircraft to
reduce their aural detection distances
[NASA-TM-X-72644] N75-18235
A noise study of the A-6 airplane and techniques
for reducing its aural detection distance
[NASA-TM-X-72643] N75-18236
- HIRSCH, R.
Aerodynamics of the propellers of rapidly
convertible VTOL aircraft A75-24942
- HO, C.-M.
Wake cutting by a cascade of cambered blades
[AIAA PAPER 75-445] A75-25729
- HOCH, R. G.
An experimental investigation of the core engine
noise of a turbofan engine
[AIAA PAPER 75-526] A75-25790
- HODGE, W. F.
Monte Carlo analysis of inaccuracies in estimated
aircraft parameters caused by unmodeled flight
instrumentation errors
[NASA-TN-D-7712] N75-17368
- HOFMAN, C. F. G. M.
Evaluation of the effect of a yaw-rate damper on
the lateral-directional stability and control of
the Beechcraft Queen Air 80 laboratory aircraft
[NLR-TR-73105-U] N75-17374
- HOLBECH, T. A.
An experimental investigation of noise-shielding
effects for a delta-winged aircraft in flight,
wind tunnel and anechoic room
[AIAA PAPER 75-513] A75-25779
- HOLDEN, J. D.
Emission calibration of a J-58 afterburning
turbojet engine at simulated supersonic,
stratospheric flight conditions A75-23964
- HOLMES, A. E.
Application of the equivalent mechanical flap
concept to jet flapped wing-body combinations
[AD-A000431] N75-17346
- HOLMES, D. C. E.
Instrumentation and control system for an F-15
stall/spin
[NASA-TM-X-72647] N75-17353

HOLT, J. M.
Surveillance velocity measurements with least
maximum error
A75-25928

HOPKINS, H. B.
Simulation of hypersonic scramjet exhaust
[NASA-CR-2494] N75-17344

HORIKAWA, T.
On stress in service condition and estimated
fatigue life of blades in axial flow compressor
A75-23152

HOROWITZ, B. M.
Ground-based collision avoidance systems for air
traffic
A75-26062

HOSHIZAKI, H.
Measurements of supersonic jet aircraft wakes in
the stratosphere
A75-23962

HOUPIS, C. H.
A state-variable design approach for a
high-performance aerospace vehicle pitch
orientation system with variable coefficients
A75-23457

HOWARD, D. D.
High range-resolution monopulse tracking radar and
applications
A75-26041

HUBBARD, H. H.
Noise reduction studies for the U-10 airplane
[NASA-TM-X-72640] N75-17360
A noise study of the A-6 airplane and techniques
for reducing its aural detection distance
[NASA-TM-X-72643] N75-18236

HUGHES, A. D.
The response of a vibrating structure as a
function of structural parameters
A75-22796

HUNTER, R. C.
Engine failure prediction techniques
A75-25274

HURLEY, F. I.
Measured three-dimensional effects in transonic
airfoil testing
A75-23222
Miniature probe for transonic flow direction
measurements
A75-23224

HUTTON, G. B.
The civil aircraft airworthiness data recording
programme. A study of normal operational
landing performance on subsonic civil jet aircraft
[ARC-CP-1273] N75-17320
Civil aircraft airworthiness data recording
programme. Uneven runways encountered by
subsonic jet transport aircraft during scheduled
airline operations
[ARC-CP-1287] N75-17383

ILIPP, K. W.
Effects of time-shifted data on flight determined
stability and control derivatives
[NASA-TN-D-7830] N75-18244

ILIN, I. S.
Static structural test for supersonic aircraft
A75-23233

INTANO, G. P.
Helicopter TERPS validation study, phase 1
[AD-A000423] N75-17347

ISAEV, V. I.
'Ring vortex' energy losses during centrifugal fan
operation in low output regimes
A75-23806

ISRAEL, D. B.
An overview of the upgraded third generation air
traffic control system
A75-26059

IUGOV, O. K.
Compressor and turbine characteristic
representation in algorithm for calculating
turbojet engine throttling characteristics
A75-23822

IOLDYBAEV, L. KH.
Analytic specification of compressor characteristics
A75-23816

J

JACOBS, W. F.
Application of the equivalent mechanical flap
concept to jet flapped wing-body combinations
[AD-A000431] N75-17346

JACOBSEN, R. A.
Flight test investigation of the vortex wake
characteristics behind a Boeing 727 during
two-segment and normal ILS approaches (A joint
NASA/FAA report)
[NASA-TM-X-62398] N75-17340

JACOBSON, I. D.
Preliminary ride-quality evaluation of the HM.2
Hoverferry
[NASA-CR-142290] N75-17338

JAKUBOWSKI, A. K.
Turbulent wake behind slender bodies including
self-propelled configurations
[AD-A001040] N75-17319

JAMESON, A.
Supercritical wing sections 2, volume 108
[NASA-CR-142229] N75-18167

JARVIS, C. R.
An overview of NASA's digital fly-by-wire
technology development program
N75-18246

JAUMOTTE, A.
Experimental study of a two pressure stage air
cushion
[NT-36] N75-18174

JEFFERY, R. W.
An experimental investigation of noise-shielding
effects for a delta-winged aircraft in flight,
wind tunnel and anechoic room
[AIAA PAPER 75-513] A75-25779

JOHNSTON, D. E.
Flight control systems properties and problems,
volume 1
[NASA-CR-2500] N75-17371
Flight control systems properties and problems.
Volume 2: Block diagram compendium
[NASA-CR-2501] N75-17372

JONES, D. S.
The scattering of sound by a vortex sheet
A75-22934

JONES, J. L.
NASA's role in aeronautics
A75-25713

JONES, L. V. C.
Study of solid state remote control techniques as
applied to the redesign of the electrical system
in a large civil aircraft
[ARC-CP-1289] N75-17364

JONES, R. D.
AEROSAT test and evaluation avionics
A75-26043

JONES, S. B.
Study of alternative beacon based surveillance and
data link systems, volume 2
[AD-772136] N75-17325

JOSHI, H. C.
Experimental investigation of the aeroacoustic
characteristics of model slot nozzles with
straight flaps
[AIAA PAPER 75-471] A75-25746

JOUANNET, J. C.
Experimental study of the unsteady flow through a
turbomachine stage
A75-23947

K

KADMAN, Y.
Diagnostic calculations of airframe-radiated noise
[AIAA PAPER 75-485] A75-25755
Prediction of airframe noise
[NASA-TN-D-7821] N75-18182

KAJI, S.
Noncompact source effect on the prediction of tone
noise from a fan rotor
[AIAA PAPER 75-446] A75-25730

KANENSKII, A. M.
Theory of astronomical correction
A75-23395

KANTOLA, R. A.
Outdoor jet noise facility, a unique approach
[AIAA PAPER 75-530] A75-25792

- KAPLAN, R. E.
Experiments on supersonic jet noise
[AIAA PAPER 75-478] A75-25751
- KATARV, IU. P.
Stress-strain state and springback in
elastic-plastic torsion of profiles with open
cross section contour A75-23809
- KATZMAN, H.
Hydrocarbon emissions from jet engines operated at
simulated high-altitude supersonic flight
conditions A75-23963
- KAWAGUTI, M.
Characteristics of air bearings with small inlet
holes for a precision coordinate measuring device
A75-25715
- KAYNES, I. W.
Gust loads on 707 and VC 10 aircraft
[ARC-CP-1281] N75-17373
- KAZIM, S. B.
Turbine noise generation, reduction and prediction
[AIAA PAPER 75-449] A75-25731
- KEATING, S. J., JR.
The transport of nuclear power plant components
A75-26016
- KELLY, G.
Automatic Test System Jet Engine Accessories
A75-23649
- KEMPKE, E. E., JR.
Technology for reducing aircraft engine pollution
[NASA-TM-X-71670] N75-18237
- KENYON, R. E.
Weapon system costing methodology for aircraft
airframes and basic structures. Volume 3: Cost
data base
[AD-A000399] N75-17348
- KESHAVAN, N. R.
Separation of turbulent boundary layer on a
lifting cylinder A75-23223
- KESLER, D. P.
Stabilization of externally slung helicopter loads
[AD-A000893] N75-18224
- KESTER, J. D.
Review of theory and methods for turbine noise
prediction
[AIAA PAPER 75-540] A75-25802
- KIEDRZYNSKI, A.
Experimental study of a two pressure stage air
cushion
[NT-36] N75-18174
- KIE, D. G.
Measurement of advanced composition materials
shielding effectiveness
[AD-A000414] N75-17425
- KINSLOW, H.
Static pressure on sharp and blunt cones in
conical and parallel low-density flow
[AD-A001632] N75-18191
- KIRKPATRICK, D. L. I.
Low-speed wind-tunnel tests on the lift-dependent
drag of delta wings with conical camber
[ARC-CP-1293] N75-17306
- KIRKPATRICK, J. P.
Navy Aircrew Escape Propulsion System Program
A75-25054
- KISLIN, B.
Proposed windshield for B-1 aircraft: An optical
evaluation
[AD-A001078] N75-17350
- KITTREDGE, P.
Millimeter radar for low angle tracking
A75-26038
- KLEINER, H. J.
The design and construction of the CAD-1 airship
A75-26002
- KLEVENHUSEN, K. D.
Contribution to the study of supercritical profile
flow
[DGLR PAPER 74-99] A75-24146
- KNIGHT, C. R.
Warranties as a life-cycle-cost management tool
A75-26099
- KNIP, G.
Preliminary study of advanced turbofans for low
energy consumption
[NASA-TM-X-71663] N75-18241
- KO, H. W. M.
Aircraft noise in a high-rise city
A75-24000
- KOCHENDOERFER, R.
The use of fiber-reinforced materials for
compressor blades
[DGLR PAPER 74-122] A75-24159
- KOLOSOV, IU. A.
Automatic balancing of rotors in high-speed machines
A75-23397
- KOMATSU, K.
On the natural vibration of plate-beam combination
structures, 4
[NAL-TR-363] N75-17707
- KONSTANTINOV, V. D.
Handbook for aircraft mechanics /3rd revised and
enlarged edition/
A75-23366
- KOOPMAN, B. O.
Potential ASW missions for lighter than air ships
A75-26014
- KOPPE, E.
Methods for the determination of noise protection
areas in accordance with the law for protection
against aircraft noise
[DGLR PAPER 74-110] A75-24150
- KORN, A. O.
Unmanned powered balloons
A75-26020
- KORN, D.
Supercritical wing sections 2, volume 108
[NASA-CR-142229] N75-18167
- KORNEV, B. N.
Analysis of thin-wall circular fuselage in damage
zone
A75-23801
- KORNSTAEDT, H.-J.
RTOL and steep approach - Why
[DGLR PAPER 74-112] A75-24152
- KOSOWSKI, S.
Stationary reaction of a dual-sphere configuration
moving in a free-molecular medium
[REPT-36/1973] N75-18172
- KOVASZNAV, L. S. G.
Wake cutting by a cascade of cambered blades
[AIAA PAPER 75-445] A75-25729
- KRAFT, E. M.
Analytical study of ventilated wind tunnel
boundary interference on V/STOL models including
wake curvature and decay effects
[NASA-CR-142240] N75-18188
- KRIER, G. E.
A pilot's opinion of the F-8 digital fly-by-wire
airplane
N75-18252
- KUBBAT, W.
The devising of control systems with the help of
computer-aided design and their application
[DGLR PAPER 74-78] A75-24135
- KUCKUCK, H.-H.
Mobile lounge or fixed gate
A75-25343
- KUENZI, H. P.
Supercritical wing sections 2, volume 108
[NASA-CR-142229] N75-18167
- KUHLTHAU, A. R.
Preliminary ride-quality evaluation of the HM.2
Hoverferry
[NASA-CR-142290] N75-17338
- KUINDZHI, A. A.
Automatic balancing of rotors in high-speed machines
A75-23397
- KUNAGAI, T.
Preliminary experiments on film cooling of turbine
blades with injection near the leading edge. 1:
Injection through holes located near the leading
edge
[NAL-TR-371] N75-17359
- KURKOWSKI, R. L.
Flight test investigation of the vortex wake
characteristics behind a Boeing 727 during
two-segment and normal ILS approaches (A joint
NASA/FAA report)
[NASA-TM-X-62398] N75-17340
- KUTINOV, V. F.
Static structural test for supersonic aircraft
A75-23233

KUTLER, P.

PERSONAL AUTHOR INDEX

KUTLER, P.
Numerical solutions for supersonic corner flow
A75-23295

KUZNETSOV, A. N.
The IL-18 aircraft /2nd enlarged and revised
edition/
A75-23421

KUZNETSOV, V. I.
Exploitation of air conditioning systems for
passenger aircraft
A75-23375

L

LABITT, M.
Advanced signal processing for airport
surveillance radars
A75-26037

LACKMAN, L. M.
Cost-competitive B-1 composite secondary structures
[SME PAPER EM74-732]
A75-23443

LAFUZE, D. L.
VSCP starter generator
A75-23594

LALLEMAND ABELLA, E.
The institutionalization and the general problems
of air traffic
A75-23348

LANBOURNE, M. C.
Comparison between dynamic stability boundaries
for NPL 9615 and NACA 0012 aerofoils pitching
about the quarter-chord
[ARC-CP-1279]
N75-17302

LANDER, H. R., JR.
Jet fuel thermal stability improvements through
fuel processing
[AD-A001623]
N75-17531

LANGFELDER, H.
The technology of the aircraft MRCA and its systems
[DGLR PAPER 74-63]
A75-24129

LARCOMBE, M. J.
A prediction method for pressure distributions on
compression surfaces of conical bodies at
supersonic speeds
[ARC-CP-1295]
N75-17307

LARIONOV, M. G.
Substantiation of discrete-continuum
low-aspect-ratio wing structural analysis scheme
A75-23798

LASAGNA, P. L.
Measurements and analysis of aircraft airframe noise
[AIAA PAPER 75-510]
A75-25776

LAUFER, J.
Experiments on supersonic jet noise
[AIAA PAPER 75-478]
A75-25751

LAURIE-LEAN, D. W.
The flight investigation and analysis of
longitudinal handling qualities of STOL aircraft
on landing approach
[AD-A001596]
N75-18254

LAWRENCE, D.
The measurement of the McDonnell-Douglas DC-9
trailing vortex system using the tower fly-by
technique
[AD-A001456/3]
N75-18222

LAWTON, B. W.
Ground noise measurements during static and flyby
operations of the Cessna 02-T turbine powered
airplane
[NASA-TM-X-72642]
N75-18234

LECAHN, R. P.
The future of real time telemetry systems
A75-23889

LEE, A.
The development of experimental techniques for the
study of helicopter rotor noise
[AIAA PAPER 75-455]
A75-25736

LEHTINEN, P. B.
Multilevel control optimization using subsystem
relative performance index sensitivity
A75-25098

LEINHANN, H.
Methods for the determination of noise protection
areas in accordance with the law for protection
against aircraft noise
[DGLR PAPER 74-110]
A75-24150

LEININGER, G. G.
Multilevel control optimization using subsystem
relative performance index sensitivity
A75-25098

LEITER, E.
The subsonic-supersonic analogy
A75-25459

LELAND, T. J. W.
Landing impact studies of a 0.3-scale model air
cushion landing system for a Navy fighter airplane
[NASA-TN-D-7875]
N75-17342

LENG, J.
Simulation of hypersonic scramjet exhaust
[NASA-CR-2494]
N75-17344

LESHNER, H. D.
Combustion intensity and distribution relation to
noise generation
[AIAA PAPER 75-524]
A75-25788

LESNIKOV, V. P.
Investigation of the structure and properties of
niobium in vacuum and in high-velocity air streams
A75-23009

LEVERTON, J. W.
Discrete frequency rotor noise
[AIAA PAPER 75-451]
A75-25733

LEVINSKY, E. S.
Airfoil optimization utilizing a remotely
controlled flexible model. Phase 1: Low speed
wind tunnel test
[AD-A001094]
N75-18189

LEVITT, B. B.
Military applications of rigid airships
A75-26013

LIBBY, W. F.
Hydrocarbon emissions from jet engines operated at
simulated high-altitude supersonic flight
conditions
A75-23963

LICITRA, M. C.
Millimeter radar for low angle tracking
A75-26038

LILLY, D. S.
Aeroflight communications and RF nav aids
A75-23912

LJUNGSTROM, B. L. G.
The viscous flow around a two dimensional high
lift wing. Analysis of boundary layer
measurements
[PPA-TN-AU-1155]
N75-17310

LNAB, F.
Broadband noise generated by turbulent inflow to
rotor or stator blades in an annular duct
[NASA-CR-2503]
N75-17361

LOCK, W. P.
Mechanization of and experience with a triplex
fly-by-wire backup control system
N75-18248

LOEWENSTEIN, M.
Measurements of supersonic jet aircraft wakes in
the stratosphere
A75-23962

LOPEZ, M. L.
Methods for predicting the aerodynamic and
stability and control characteristics of STOL
aircraft. Volume 1: Basic theoretical methods
[AD-A001580]
N75-17375

Methods for predicting the aerodynamic and
stability and control characteristics of STOL
aircraft. Volume 3: Engineering methods
[AD-A001582]
N75-17377

LOBBAIN, M.
A new biaxial tensile testing machine
A75-24068

LOTZ, M.
Transonic wing design and its effects on flight
performance
[DGLR PAPER 74-97]
A75-24144

LOWRIE, B. W.
Simulation of flight effects on aero engine fan
noise
[AIAA PAPER 75-463]
A75-25739

LOWSON, M. V.
Propagation of sound in elliptic ducts
A75-22791

Noise of high speed rotors
[AIAA PAPER 75-450]
A75-25732

PERSONAL AUTHOR INDEX

MERCER, C. E.

- LUNDY, J. L.
Aerodynamic design and analysis system for
supersonic aircraft. Part 1: General
description and theoretical development
[NASA-CR-2520] N75-18185
Aerodynamic design and analysis system for
supersonic aircraft. Part 3: Computer program
description
[NASA-CR-2522] N75-18186
- LOPINETTI, A. A.
Test bed for the upgraded third generation Air
Traffic Control System A75-26064
- LOU, T. S.
Unsteady flow through a turbomachine stage with
free vortex shed A75-23945
Calculation by the singularity method of the
characteristics of a cascade in compressible
flow without knocking up to the supercritical
speed A75-23988
- LYNNWORTH, L. C.
Nonintrusive ultrasonic measurement of flow
velocity and mass flow rate A75-22880
Ultrasonic flowmeter cell designs for liquids
A75-25951
- M**
- MACDONALD, P. F.
Cost-competitive B-1 composite secondary structures
[SME PAPER EN74-732] A75-23443
- MACKRODT, P.-A.
Some aspects of Hybrid-Zeppelins A75-26008
- MACPHERSON, J. I.
Results of intercomparison flights between the
NAB-T-33 and the NCAR Buffalo atmospheric
Research aircraft
[AD-A001436] N75-17352
- MADSEN, R. T.
Effect of present technology on airship capabilities
A75-25974
- MAESTRELLO, L.
New evidence of subsonic jet noise mechanisms
[AIAA PAPER 75-437] A75-25724
- MAGADEEV, A. IA.
Analytic specification of compressor characteristics
A75-23816
- MAIERSPERGER, W. P.
Design aspects of zeppelin operations from case
histories A75-25994
- MALLOY, W. A.
The effects of lightning on digital flight control
systems N75-18249
- MANDERS, A. M.
Study of alternative beacon based surveillance and
data link systems, volume 2
[AD-772136] N75-17325
- MARBERT, J. A.
Static and wind tunnel model tests for the
development of externally blown flap noise
reduction techniques
[NASA-CR-134675] N75-18177
- MARBURY, P.
Floating vs flying - A propulsion energy comparison
A75-25987
- MARCHAND, W.
Laterally displaced ISLS antenna for tactical radar
A75-25926
- MARCUS, H. S.
An approach to market analysis for lighter than
air transportation of freight A75-25979
- MARSH, H.
The steady state and dynamic behaviour of the
turbo-bearing A75-23615
- MARTEL, C. R.
Jet fuel thermal stability improvements through
fuel processing
[AD-A001623] N75-17531
- MARTIN, C. W.
An iterative improvement for finite element analysis
A75-25212
- MARTINEZ SARANDESES, A.
Aids to air navigation A75-23349
- MASO, J.-C.
A new biaxial tensile testing machine A75-24068
- MATHEWS, D. C.
Review of theory and methods for turbine noise
prediction
[AIAA PAPER 75-540] A75-25802
- MATSCHAT, K.
Methods for the determination of noise protection
areas in accordance with the law for protection
against aircraft noise
[DGLR PAPER 74-110] A75-24150
- MATTA, R. K.
Turbine noise generation, reduction and prediction
[AIAA PAPER 75-449] A75-25731
- MAUS, J. E.
Experimental investigation of the aeroacoustic
characteristics of model slot nozzles with
straight flaps
[AIAA PAPER 75-471] A75-25746
- MAYER, J. E.
FAA JT3D quiet nacelle retrofit feasibility
program. Volume 3: Lower goal flight testing,
economic analyses and summary
[AD-787610] N75-17334
- MAYER, H. J.
LTA structures and materials technology A75-25991
- MAZZA, C. J.
The effects of selected modern technological
concepts on the performance and handling
characteristics of LTA vehicles A75-25982
- MCBRIDE, W. S.
Factors in the design of solid oxygen systems for
aircraft A75-25061
- MCCLURKEN, E. W., JR.
Preliminary ride-quality evaluation of the HM.2
Hoverferry
[NASA-CR-142290] N75-17338
- MCDONALD, G. H.
Catalytic reactor for inerting of aircraft fuel
tanks
[AD-A000939] N75-18228
- MCROWEN, L. J.
Combining strength and fracture toughness A75-24002
- MCNURTNEY, T. C.
Flight test investigation of the vortex wake
characteristics behind a Boeing 727 during
two-segment and normal ILS approaches (A joint
NASA/FAA report)
[NASA-TN-X-62398] N75-17340
- MCROVER, D. T.
Flight control systems properties and problems,
volume 1
[NASA-CR-2500] N75-17371
- MECHIN, B.
Recent progress in experimental studies of
afterbodies A75-24943
- MEECHAN, W. C.
Cross-correlation of noise produced inside a hot
turbojet exhaust with and without suppression
using a new, hot probe
[AIAA PAPER 75-505] A75-25771
- MELEKA, A. H.
Areas of ECM application, opportunities and
limitations A75-23693
- MELIYUDOV, S. I.
A limiting case of multiphase flow past slender
bodies
[AD-A000240] N75-17313
- MENKE, J. A.
A revolutionary and operational tethered aerostat
system illustrating new LTA technology A75-26023
- MERCER, C. E.
Effects of nozzle interfairing modifications on
longitudinal aerodynamic characteristics of a
twin jet, variable wing sweep fighter model
[NASA-TN-D-7817] N75-18180

- MERRINAN, J. E.
Effect of forward motion on fan noise
[AIAA PAPER 75-464] A75-25740
- METZGER, R. F.
Mechanical instability ground dynamics program
[AD-A001101] N75-17349
- MEYER, J. V.
Measurements of supersonic jet aircraft wakes in the stratosphere A75-23962
- MIDDLETON, W. D.
Aerodynamic design and analysis system for supersonic aircraft. Part 1: General description and theoretical development
[NASA-CR-2520] N75-18185
Aerodynamic design and analysis system for supersonic aircraft. Part 3: Computer program description
[NASA-CR-2522] N75-18186
- MILLER, N.
The measurement of the McDonnell-Douglas DC-9 trailing vortex system using the tower fly-by technique
[AD-A001456/3] N75-18222
- MILLER, W. M., JR.
The Dynairship A75-26007
- MINICH, M. D.
Structural response of a fiber composite compressor fan blade airfoil
[NASA-TN-X-71623] N75-17709
- MIRMACK, E. V.
A state-variable design approach for a high-performance aerospace vehicle pitch orientation system with variable coefficients A75-23457
- MITUSHKIN, I. I.
Study of annular nozzle cascades with different 'reverse' vane twist A75-23818
- MITRA, N. K.
Low Reynolds number hypersonic nozzle flows A75-24270
- MIURA, H.
Supersonic flow of a lightly dust-laden gas past a wedge A75-23298
- MIKSON, J. S.
Fluctuating pressures on aircraft wing and flap surfaces associated with powered-lift systems
[AIAA PAPER 75-472] A75-25747
- MOEBIUS, K.
A leak-free mechanical tube joint A75-23240
- MONAKHOV, M. M.
Analytic construction of function for conformal transformation of exterior of circle onto exterior of arbitrary wing profile A75-23794
- MOORE, A. W.
Comparison between dynamic stability boundaries for NPL 9615 and NACA 0012 aerofoils pitching about the quarter-chord
[ARC-CP-1279] N75-17302
- MOORE, V. S.
Coatings protect superalloys in gas-turbine applications A75-24005
- MOORYCHEV, V. B.
Using lighter than air vehicles /dirigibles/ in housing construction A75-26018
- MORGAN, K.
The diffraction of a shock wave by a slender body A75-25458
- MORRIS, R. E.
Study of active cooling for supersonic transports
[NASA-CR-132573] N75-17336
- MORRISON, R. F.
Laser gyro reaction time investigation program
[AD-A001646] N75-17332
- MOSHER, C. F.
Balloon logging with the inverted skyline A75-26026
- MOSKOVKIN, L. M.
Aircraft switching devices: Fabrication technology and installation A75-23369
- MOTIWALLA, S. K.
Optimization of structures to satisfy a flutter velocity constraint by use of quadratic equation fitting
[NASA-CR-132628] N75-17711
- MOTOSH, E.
Load distribution on threads of titanium tension nuts and steel bolts
[ASME PAPER 74-DE-N] A75-23638
- MOTSINGER, R. E.
Review of theory and methods for combustion noise prediction
[AIAA PAPER 75-541] A75-25803
- MOULTON, M.
Digital avionics - An established technology A75-24049
- HOWFORTH, E.
The Airfloat HL project A75-26004
- MUEHRE, C. E.
Advanced signal processing for airport surveillance radars A75-26037
- MUELLER, E.-A.
Methods for the determination of noise protection areas in accordance with the law for protection against aircraft noise
[DGLR PAPER 74-110] A75-24150
- MULLINS, M. L.
Long fluid filled bags suspended by line forces A75-25988
- MUNGUR, P.
Influence of grazing flow on duct wall normal impedances
[AIAA PAPER 75-494] A75-25763
Sound propagation in curved ducts
[AIAA PAPER 75-497] A75-25766
Acoustic wave propagation in a lined duct with non-uniform admittance
[AIAA PAPER 75-515] A75-25781
- MUNJAL, M. L.
Generalized aerodynamic noise equation A75-24418
- MYERS, M. K.
Sound propagation in curved ducts
[AIAA PAPER 75-497] A75-25766
- N**
- NAGEL, A. L.
Future long-range transports: Prospects for improved fuel efficiency
[NASA-TN-X-72659] N75-17339
- NAGEL, R. T.
Review of theory and methods for turbine noise prediction
[AIAA PAPER 75-540] A75-25802
- NAKAHARA, H.
On stress in service condition and estimated fatigue life of blades in axial flow compressor A75-23152
- NARODITSKAIA, I. I.
Automatic balancing of rotors in high-speed machines A75-23397
- NASTASE, A.
The effect of initial values on wing form and the limiting curve of the wave drag coefficients of optimized symmetrical-thick delta wings in supersonic flow A75-23100
- NEAL, G. L.
Modern control - Modeling and application in real aircraft flight control system design A75-24758
- NEBIKER, P. R.
An LTA flight research vehicle A75-26003
- NELSON, W. D.
Advanced composite design concepts for the AMST
[SAE PAPER 740870] A75-22944
- NERI, L. M.
Evaluation of a high-capacity, firefighting foam-dispensing system
[AD-A006264] N75-18259
- NEUMANN, H. E.
Design of a very-low-bleed Mach 2.5 mixed-compression inlet with 45 percent internal contraction
[NASA-TN-X-3135] N75-17363

- BEUMANN, R.
The Slate all metal airship
A75-25998
- NICHOLS, J. B.
The basic characteristics of hybrid aircraft
A75-26005
- MISSIN, E.
Flutter suppression and gust alleviation using active controls
[NASA-CR-142195] N75-18243
- HITSCHKE, V.
A contribution to the problem of noise produced at the takeoff and landing of VTOL aircraft
[DGLR PAPER 74-116] A75-24153
- MOSSEIR, H. S. H.
Tests of a theoretical model of jet noise
[AIAA PAPER 75-436] A75-25723
- NYLEN, W. E.
Engineering simulation development and evaluation of the two-segment noise abatement approach conducted in the B-727-222 flight simulator
[NASA-CR-137594] N75-18195
- O
- OCOENOR, W. H.
AFTI TI-1 program
[SAE PAPER 740860] A75-22939
- ODONALD, B. T.
Simulation - An aid to aircraft maintenance management
A75-24756
- ODOHNEILL, R. H.
Advanced signal processing for airport surveillance radars
A75-26037
- OESTERHELT, G.
The devising of control systems with the help of computer-aided design and their application
[DGLR PAPER 74-78] A75-24135
- OESTRICH, P. F.
YF-16 flight test program - Lightweight fighter program
A75-24808
- OKAZAKI, S.
On stress in service condition and estimated fatigue life of blades in axial flow compressor
A75-23152
- OKKEPE, J. V.
Noise shielding effects for engine-over-wing installations
[AIAA PAPER 75-474] A75-25749
- OHAN, R. A.
Simulation of hypersonic scramjet exhaust
[NASA-CR-2494] N75-17344
- ONCLEY, P. B.
Review of theory and methods for the prediction of ground effects on aircraft noise propagation
[AIAA PAPER 75-538] A75-25800
- ORNSTON, R. A.
Flapping response characteristics of hingeless rotor blades by a generalized harmonic balance method
[NASA-TN-D-7856] N75-18183
- ORNSTEIN, E.
Millimeter radar for low angle tracking
A75-26038
- OSTROFF, H. S.
P-15 secondary power systems
[SAE PAPER 740885] A75-22948
- P
- PADDISON, P. C.
Surface effect takeoff and landing system (SETOLS)
[AD-A000101] N75-17345
- PAGE, N. W.
Atmospheric refraction of sonic boom from aircraft at low supersonic speeds
[AIAA PAPER 75-547] A75-25809
- PAKE, P. A.
Boundary layer control for airships
A75-25983
- PAN, C. H. T.
Diagonalization of the bearing matrix - A systematic method for the analysis of rotor-bearing dynamics
A75-23614
- PAN, Y. S.
Noise radiation from turbulent flows over compliant surfaces
[AIAA PAPER 75-507] A75-25773
- PANUZZIO, S.
Ambient and induced pressure fluctuations in supersonic jet flows
[AIAA PAPER 75-482] A75-25754
- PAO, S. P.
New evidence of subsonic jet noise mechanisms
[AIAA PAPER 75-437] A75-25724
- PAPADAKIS, E. P.
Nonintrusive ultrasonic measurement of flow velocity and mass flow rate
A75-22880
- PAPST, H.
Method for transporting impellent gases
A75-26001
- PARKER, H. M.
An investigation of rooftop STOL port aerodynamics
[NASA-CR-132570] N75-17381
- PARKER, L. C.
Pilot preference and procedures at uncontrolled airports
[NASA-TN-D-7928] N75-18169
- PARTHASARATHY, S. P.
Jet noise source location by cross-correlation of far field microphone signals
[AIAA PAPER 75-456] A75-25737
- PASHCHENKO, A. P.
VTOL airplane control in transition regimes
[AD-A000128] N75-17378
- PATTERSON, G. T.
Experimental investigation of the aeroacoustic characteristics of model slot nozzles with straight flaps
[AIAA PAPER 75-471] A75-25746
- PAVLECKA, V. E.
State of the art of metalclad airships
A75-25999
- PAVLOV, V. A.
On empennage stability
A75-23802
- PAXSON, R. P.
Near field noise prediction for a linear array of turbojet engines
[AD-A001329] N75-18976
- PEARSON, R. J.
Breaking with tradition
A75-25125
- PEDERSEN, N. E.
Nonintrusive ultrasonic measurement of flow velocity and mass flow rate
A75-22880
- PEGG, R. J.
Thickness noise of helicopter rotors at high tip speeds
[AIAA PAPER 75-453] A75-25735
- PENDLEY, R. E.
Recent advances in the technology of aircraft noise control
[AIAA PAPER 75-317] A75-25014
- PENNOCK, A. F.
Static and wind tunnel model tests for the development of externally blown flap noise reduction techniques
[NASA-CR-134675] N75-18177
- PERKINS, E. G., JR.
Aerocrane - A hybrid LTA aircraft for aerial crane applications
A75-26019
- PERRY, B., III
Wind tunnel investigation of aerodynamic loads on a large-scale externally blown flap model and comparison with theory
[NASA-TN-D-7863] N75-17294
- PETERS, D. A.
Flapping response characteristics of hingeless rotor blades by a generalized harmonic balance method
[NASA-TN-D-7856] N75-18183
- PETERSEN, W. E.
Mechanization of and experience with a triplex fly-by-wire backup control system
N75-18248
- PETRONE, P. J.
Special problems and capabilities of high altitude lighter than air vehicles
A75-26021

- PHILLIPS, M. A.
First results of a general circulation model
applied to the SST-MOx problem
A75-23982
- PIASECKI, P. M.
Ultra-heavy vertical lift system 'The Heli-Stat'
A75-26009
- PICKARD, J.
Matrix difference equation analysis of vibrating
periodic structures
A75-23201
- PICKETT, G. F.
Core engine noise due to temperature fluctuations
convecting through turbine blade rows
[AIAA PAPER 75-528]
A75-25791
- PIPTONE, S. J.
Boundary layer control for airships
A75-25983
- PITTS, P. L.
Instrumentation and control system for an F-15
stall/spin
[NASA-TM-X-72647]
N75-17353
- PLETT, R. G.
Combustion intensity and distribution relation to
noise generation
[AIAA PAPER 75-524]
A75-25788
- PLUMER, J. A.
The effects of lightning on digital flight control
systems
N75-18249
- PLZAK, G. A.
Near field noise prediction for a linear array of
turbojet engines
[AD-A001329]
N75-18976
- POHL, R. A.
Two lighter than air systems in opposing flight
regimes - An unmanned short haul, heavy load
transport balloon and a manned, light payload
airship
A75-26025
- POKROVSKII, V. IA.
The Il-18 aircraft /2nd enlarged and revised
edition/
A75-23421
- POLIKUSHIN, V. M.
The Il-18 aircraft /2nd enlarged and revised
edition/
A75-23421
- POLLOCK, J. H.
An approach to market analysis for lighter than
air transportation of freight
A75-25979
- POLLOCK, N.
Transonic wind tunnel tests on two blunt trailing
edge aerofoils
[ARL/A-NOTE-351]
N75-18175
- PORTER, T. R.
Comparisons of the ballistic impact response of
metals and composites for military aircraft
applications
A75-25230
- POSTON, A. M.
US Army Human Engineering Laboratory helicopter
cockpit lighting study. Phase 1: An evaluation
of current and potential instrument panel
lighting techniques for use in Army helicopters
[AD-A001527]
N75-17351
- PREISSER, J. S.
Acoustic characteristics of a large upper-surface
blown configuration with turbofan engines
[AIAA PAPER 75-473]
A75-25748
- PRENET, L. A.
The Il-18 aircraft /2nd enlarged and revised
edition/
A75-23421
- PRESTON, J. L., JR.
Impact response of graphite-epoxy flat laminates
using projectiles that simulate aircraft engine
encounters
A75-25232
- PREUSS, T.
Static computation of a wing model made of carbon
fiber reinforced plastic /bending-torsion box/
with the aid of the method of finite elements
and a comparison with experimental values
[DGLR PAPER 74-118]
A75-24155
- PRICE, W. L.
Forecasting traffic in an air transport network
A75-24341
- PRINN, R. G.
First results of a general circulation model
applied to the SST-MOx problem
A75-23982
- PROVINES, W. P.
Proposed windshield for B-1 aircraft: An optical
evaluation
[AD-A001078]
N75-17350
- PUGHAN, W. P.
The effect of ground proximity on the
lateral/directional aerodynamic and control
characteristics of a tilt-wing V/STOL aircraft
at high lift coefficients
[AD-A001584]
N75-18227
- PUGHAN, T. W.
Measurements and analysis of aircraft airframe noise
[AIAA PAPER 75-510]
A75-25776
- PUZYREV, V. A.
Analysis of frequency error of airplane descent
rate measured by a laser
A75-23797
- Q**
- QUILLEVERE, A.
Design of low-pollution burners
A75-24945
- R**
- RADFORD, R. C.
Report on program to improve MIL-F-83300
[AD-A001598]
N75-18226
- RAISBECK, G.
Potential ASW missions for lighter than air ships
A75-26014
- RAKHMATULIN, K.
A limiting case of multiphase flow past slender
bodies
[AD-A000240]
N75-17313
- RANEY, J. P.
Development of a new computer system for aircraft
noise prediction
[AIAA PAPER 75-536]
A75-25798
- RAO, G. V.
Fundamental frequency of a square panel with
multiple point supports on edges
A75-22798
- RAO, S. S.
Finite element flutter analysis of multi-web wing
structures
A75-22795
- A finite element approach to the aeroelastic
analysis of lifting surface type structures
A75-24918
- RASMUSSEN, H.
Application of a variational method in plane
compressible flow calculation
[ARC-CP-1284]
N75-17303
- RAWLINSON, P. E.
ASR-5 radar dual feedhorn antenna modification.
Volume 1: Description of hardware and summary
of feasibility effort
[AD-781348]
N75-17573
- RAY, R. A.
A state-variable design approach for a
high-performance aerospace vehicle pitch
orientation system with variable coefficients
A75-23457
- REBOUX, J.
Flow determination at the exit of a moving
supersonic annular blade cascade
[ONERA, TP NO. 1370]
A75-23946
- REEDER, J. P.
A flight research program to develop airborne
systems for improved terminal area operations
A75-24803
- REGAN, D. R.
Cross-correlation of noise produced inside a hot
turbojet exhaust with and without suppression
using a new, hot probe
[AIAA PAPER 75-505]
A75-25771
- REGAN, P. J.
The planar dynamics of airships
A75-25986

- REINECKE, W. G.
Influence of velocity, impingement angle, heating,
and aerodynamic shock layers on erosion of
materials at velocities of 5500 ft per s /1700 m
per s/
A75-25188
- REWARD, P.
Study of materials and nonmetallic coatings for
erosion and wear resistance
A75-23942
- RESCH, R. D.
Computer aided flexible envelope designs
A75-25989
- REUBUSH, D. E.
Effects of nozzle interfairing modifications on
longitudinal aerodynamic characteristics of a
twin jet, variable wing sweep fighter model
[NASA-TN-D-7817]
N75-18180
- REVELL, J. D.
Induced drag effect on airframe noise
[AIAA PAPER 75-487]
A75-25757
Methods for the prediction of airframe aerodynamic
noise
[AIAA PAPER 75-539]
A75-25801
- REYNOLDS, D. R.
An integrated PCM data system for full scale
aeronautics testing
A75-23902
- RIBNER, H. S.
Tests of a theoretical model of jet noise
[AIAA PAPER 75-436]
A75-25723
- RICHTER, W. L.
S-3A Design-to-a-Cost program
[SHE PAPER MM74-710]
A75-23439
- RIEGER, G.
Methods of production planning in aircraft
maintenance
A75-23045
- RINEHART, S. A.
Development of an analysis for the determination
of coupled helicopter rotor/control system
dynamic response. Part 1: Analysis and
applications
[NASA-CR-2452]
N75-18178
- RIVA, D.
Laterally displaced ISLS antenna for tactical radar
A75-25926
- ROBERTS, P. O.
An approach to market analysis for lighter than
air transportation of freight
A75-25979
- ROBINSON, G. H.
Flight test investigation of the vortex wake
characteristics behind a Boeing 727 during
two-segment and normal ILS approaches (A joint
NASA/FAA report)
[NASA-TN-X-62398]
N75-17340
- RODA, J.
State of the art of metalclad airships
A75-25999
- ROEPKE, W.
Applications of electronic data processing in
aircraft maintenance
A75-23048
- ROPPE, G.
Prevaporization and premixing to obtain low oxides
of nitrogen in gas turbine combustors
[NASA-CR-2495]
N75-17362
- ROSELIUS, D. A.
Advanced composite design concepts for the AMST
[SAE PAPER 740870]
A75-22944
- ROSENDAHL, C. E.
Where do we go from here
A75-25970
- ROTH, S.
The Alpha-Jet spoiler of carbon-epoxy material
[DGLR PAPER 74-119]
A75-24156
- ROUNDHILL, J. P.
Model and full scale test results relating to fan
noise in-flight effects
[AIAA PAPER 75-465]
A75-25741
- ROUSSEAU, J.
Catalytic reactor for inerting of aircraft fuel
tanks
[AD-A000939]
N75-18228
- RUBINGER, B.
Performance survey of the air traffic control
radar beacon system
A75-23459
- RUDEY, R. A.
Technology for reducing aircraft engine pollution
[NASA-TN-X-71670]
N75-18237
- RUDY, S. L.
Effects of fatigue and dynamic recovery on rain
erosion
A75-25189
- RYMER, J. W.
Flexibility objectives for real-time telemetry
processing systems
A75-23887

S

- SABO, D.
A crashworthy armored helicopter crew seat
A75-25055
- SAGE, A. P.
VTOL flight-control system design using
sensitivity analysis
A75-25879
- SAHREL, R. H.
AEROSAT test and evaluation avionics
A75-26043
- SALMON, H.
A solution to the transport of exceptionally large
loads - The dirigible
A75-23199
- SAMS, D. D.
Pilot control/display factors for helicopters
/PIFAX-H/
A75-25070
- SANDERS, K.
Method of balancing VTOL aircraft
[SAWE PAPER SWR 7]
A75-24348
- SASAKI, H.
Preliminary experiments on film cooling of turbine
blades with injection near the leading edge. 1:
Injection through holes located near the leading
edge
[NAL-TR-371]
N75-17359
- SASHEVSKII, V. V.
Laboratory evaluation of the stability of
high-purity jet fuels of the T-8 type and of the
effectiveness of antioxidants
A75-24274
- SASTRY, H. S.
Hypersonic viscous slip flow over an insulated
flat plate with real gas effects
A75-23205
- SAWDY, D. T.
Computational methods for acoustic radiation from
circular ducts
[AIAA PAPER 75-516]
A75-25782
Effects of a conical segment on sound radiation
from a circular duct
[AIAA PAPER 75-517]
A75-25783
- SCHAEHNER, G.
The design of flight control devices with the aid
of modern system theory
[DGLR PAPER 74-77]
A75-24134
- SCHAPPELLE, R. H.
Airfoil optimization utilizing a remotely
controlled flexible model. Phase 1: Low speed
wind tunnel test
[AD-A001094]
N75-18189
- SCHARTON, T. D.
Acoustic transmission through a fuselage sidewall
[NASA-CR-132602]
N75-18971
- SCHAUT, L. A.
Model and full scale test results relating to fan
noise in-flight effects
[AIAA PAPER 75-465]
A75-25741
- SCHIECHL, L.
Fire-fighting in airport premises
A75-25342
- SCHETZ, J. A.
Turbulent wake behind slender bodies including
self-propelled configurations
[AD-A001040]
N75-17319
Skin friction reduction in supersonic flow by
injection through slots, porous sections and
combinations of the two
[NASA-CR-2491]
N75-17614
- SCHLEIFF, R.
The determination of the subsonic flow of a
Chaplygin gas around a circular profile in the
presence of circulation
A75-24061

- SCHLINKER, R.
Experiments on supersonic jet noise
[AIAA PAPER 75-478] A75-25751
- SCHMITT, D.
Wind tunnel investigations on an airplane model with variable sweepback in the incompressible region. Part 1: Comparison of the most important experimental parameters and their influence on the aerodynamic coefficients
[IPD-4/73-PT-1] N75-17298
- SCHMITT, G. P., JR.
Influence of velocity, impingement angle, heating, and aerodynamic shock layers on erosion of materials at velocities of 5500 ft per s /1700 m per s/
A75-25188
- SCHNEIDER, H.
Static computation of a wing model made of carbon fiber reinforced plastic /bending-torsion box/ with the aid of the method of finite elements and a comparison with experimental values
[DGLR PAPER 74-118] A75-24155
- SCHNEIDER, R.
The design and construction of the CAD-1 airship
A75-26002
- SCHNEIDER, S. H.
Possible climatic effects of supersonic transports
A75-23973
- SCHNELL, H.
Development of a VFW-614 spoiler in a design utilizing boron fiber reinforced plastic
[DGLR PAPER 74-121] A75-24158
- SCHOENSTER, J. A.
Fluctuating pressures on aircraft wing and flap surfaces associated with powered-lift systems
[AIAA PAPER 75-472] A75-25747
- SCHROEDER, R.
A spatial theory for the ground resonance of helicopters
[ESRO-TT-108] N75-17297
- SCHUBERT, H.
The determination of the subsonic flow of a Chaplygin gas around a circular profile in the presence of circulation
A75-24061
- SCHULMAN, M.
A crashworthy armored helicopter crew seat
A75-25055
- SCHWARTZ, I. R.
Minimization of jet and core noise of a turbojet engine by swirling the exhaust flow
[AIAA PAPER 75-503] A75-25769
- SERNANN, G. R.
Remotely piloted LTA vehicle for surveillance
A75-26028
- SELIVANOV, O. D.
Compressor and turbine characteristic representation in algorithm for calculating turbojet engine throttling characteristics
A75-23822
- SELLERS, W. L., III
A model for the vortex pair associated with a jet in a cross flow
[NASA-CR-136756] N75-17611
- SENZ, R. R.
Fracture mechanics' impact on specifications and supply
A75-24004
- SERGEYEV, E. A.
The future application of aircraft-borne digital computers in complex-automated adaptive control systems for flight vehicles
[AD-A000193] N75-18253
- SERTOUR, G.
Study of materials and nonmetallic coatings for erosion and wear resistance
A75-23942
- The use of titanium and its alloys in the manufacture of helicopters and aircraft structures
[BR44857] N75-17337
- SHANIS, E. E.
Using lighter than air vehicles /dirigibles/ in housing construction
A75-26018
- SHAMRIKOV, B. M.
The future application of aircraft-borne digital computers in complex-automated adaptive control systems for flight vehicles
[AD-A000193] N75-18253
- SHANKAR, V.
Numerical solutions for supersonic corner flow
A75-23295
- SHANNON, G. P.
Manual control system design using a dual suboptimal control model
A75-24839
- SHARPLEY, W. K.
AN/ASN-90 systems improvement program
[AD-A001647] N75-17333
- SHAW, R. J.
Design of a very-low-bleed Mach 2.5 mixed-compression inlet with 45 percent internal contraction
[NASA-TN-X-3135] N75-17363
- SHEA, W. P.
Lighter than air - A look at the past, a look at the possibilities
A75-25995
- SHEARIN, J. G.
Airframe noise measurements on a transport model in a quiet flow facility
[AIAA PAPER 75-509] A75-25775
- A preliminary investigation of remotely piloted vehicles for airframe noise research
[AIAA PAPER 75-512] A75-25778
- SHELDON, D.
Airship stresses due to vertical velocity gradients and atmospheric turbulence
A75-25984
- SHEN, C. C.
Methods for predicting the aerodynamic and stability and control characteristics of STOL aircraft. Volume 1: Basic theoretical methods
[AD-A001580] N75-17375
- SHEVELKO, P. S.
Handbook for aircraft mechanics /3rd revised and enlarged edition/
A75-23366
- SHIPP, R. F.
AN/ASN-90 systems improvement program
[AD-A001647] N75-17333
- SHUMILOV, I. S.
Aircraft control surface actuators
A75-23423
- SIEGEL, A. I.
Survey of thin film fluorescent material
[AD-A005571] N75-18194
- SIERAKOWSKI, R. L.
Studies on the impact structural damage of composite blades
A75-25240
- SIGALLA, A.
The shape of the future long-haul transport airplane
[AIAA PAPER 75-305] A75-25012
- SINCOX, C. D.
Recent advances in exhaust systems for jet noise suppression of high speed aircraft
[AIAA PAPER 75-333] A75-25016
- SINACORI, J. B.
Stabilization of externally-slung helicopter loads
[AD-A000893] N75-18224
- SINHA, P. K.
Evaluation of stiffness coefficients for fiber-reinforced laminated composites
A75-23667
- SKLIANSKII, P. I.
Aircraft control surface actuators
A75-23423
- SLATE, C. C.
The Slate all metal airship
A75-25998
- SLEEPER, R. K.
An experimental simulation study of four crosswind landing gear concepts
[NASA-TN-D-7864] N75-18184
- SLITKOVA, V. M.
Laboratory evaluation of the stability of high-purity jet fuels of the T-8 type and of the effectiveness of antioxidants
A75-24274
- SLUTSKY, S.
Ambient and induced pressure fluctuations in supersonic jet flows
[AIAA PAPER 75-482] A75-25754
- SMITH, C. D.
Acoustic wave propagation in a lined duct with non-uniform admittance
[AIAA PAPER 75-515] A75-25781

- SMITH, C. L.
Preliminary estimates of operating costs for
lighter than air transports
A75-25972
- SMITH, D. L.
Near field noise prediction for a linear array of
turbojet engines
[AD-A001329] N75-18976
- SMITH, H. J.
Flight test investigation of the vortex wake
characteristics behind a Boeing 727 during
two-segment and normal ILS approaches (A joint
NASA/FAA report)
[NASA-TM-X-62398] N75-17340
- SMITH, J. B.
Head-up and other displays
A75-24050
- SMITH, P. B.
The noise behaviour of aero engine turbine tones
[AIAA PAPER 75-466] A75-25742
- SMITH, T. P.
Aerodynamic heating of supersonic blunt bodies
[AD-A001135] N75-18190
- SMYSLOV, V. I.
Method of electromechanical simulation of the
elastic oscillations of an aircraft in flight
[AD-A000645] N75-17385
- SOLOMONOV, P. A.
Reliability of airframes
A75-23428
- SOMSTEGAARD, M.
Airships for transporting highly volatile
commodities
A75-26017
- SOROKIN, V. G.
Investigation of the structure and properties of
niobium in vacuum and in high-velocity air streams
A75-23009
- SPAID, P. W.
Miniature probe for transonic flow direction
measurements
A75-23224
- SPEBCER, M. A.
Study of alternative beacon based surveillance and
data link systems, volume 2
[AD-772136] N75-17325
- SPRINGER, G. S.
A model for rain erosion of homogeneous materials
A75-25185
- SPOHLER, B. H.
Fracture mechanics' impact on specifications and
supply
A75-24004
- STANEWSKY, E.
Development and wind tunnel investigation of three
supercritical airfoil profiles for transport
aircraft
[DGLR PAPER 74-100] A75-24147
- STARTSEV, V. P.
Analytic construction of function for conformal
transformation of exterior of circle onto
exterior of arbitrary wing profile
A75-23794
- STAUFENBIEL, R.
Control, stabilization, and guidance of flight
vehicles
[DGLR PAPER 74-75] A75-24133
- STEEBS, S. T.
Effects of time-shifted data on flight determined
stability and control derivatives
[NASA-TM-D-7830] N75-18244
- STEHLIK, Z.
The defect recording system and defect statistics
for aircraft technology used by the CSA
A75-23047
- STEPHENSON, D. W.
Altitude evaluation of a variable cycle turbofan
engine
[SAE PAPER 740806] A75-22938
- STEPNIEWSKI, W. Z.
Documenting helicopter operations from an energy
standpoint
[NASA-CR-132578] N75-18220
- STERN, J. A.
Advanced subsonic transports - A challenge for the
1990's
[AIAA PAPER 75-304] A75-23251
- STETSON, A. B.
Coatings protect superalloys in gas-turbine
applications
A75-24005
- STEWART, H. J.
Theoretical and experimental study on the ejector
augmented jet flap
[NASA-CR-136749] N75-17296
- STIMPERT, D. L.
Acoustic test results from a 36 inch (0.914m)
statorless lift fan with serrated and unserrated
rotor blades
[NASA-CR-137622] N75-18242
- STIMMERT, G. W., JR.
Flight test investigation of the vortex wake
characteristics behind a Boeing 727 during
two-segment and normal ILS approaches (A joint
NASA/FAA report)
[NASA-TM-X-62398] N75-17340
- STINSON, L. F.
Test bed for the upgraded third generation Air
Traffic Control System
A75-26064
- STONE, R. S.
Potential ASW missions for lighter than air ships
A75-26014
- STONE, W. J.
Ejection seat steering and control
A75-25067
- STOWELL, H. B.
US Army Human Engineering Laboratory helicopter
cockpit lighting study. Phase 1: An evaluation
of current and potential instrument panel
lighting techniques for use in Army helicopters
[AD-A001527] N75-17351
- STRAHLER, W. C.
The convergence of theory and experiment in direct
combustion generated noise
[AIAA PAPER 75-522] A75-25786
- STRELKOV, S. P.
Method of electromechanical simulation of the
elastic oscillations of an aircraft in flight
[AD-A000645] N75-17385
- STRICKLER, M. K.
General aviation safety - Fact and fiction
A75-25719
- STRIGUNOV, V. M.
Stress analysis of aircraft fuselages and
pressurized cabins
A75-23231
- STRINGER, J.
Hot corrosion in gas turbines
A75-24380
- STUBBS, S. M.
An experimental simulation study of four crosswind
landing gear concepts
[NASA-TM-D-7864] N75-18184
- STURGEON, D. L. G.
Potential contribution of high strength, high
modulus aramid fibers to the commercial
feasibility of lighter than air craft
A75-25992
- SUGAVANAN, A.
Hypersonic viscous slip flow over an insulated
flat plate with real gas effects
A75-23205
- SUGINORI, S.
Characteristics of air bearings with small inlet
holes for a precision coordinate measuring device
A75-25715
- SUKHANOV, S. S.
Handbook for aircraft mechanics /3rd revised and
enlarged edition/
A75-23366
- SUMMERFIELD, M.
Combustion intensity and distribution relation to
noise generation
[AIAA PAPER 75-524] A75-25788
- SUN, C. T.
Studies on the impact structural damage of
composite blades
A75-25240
- SUN, C.-C.
Calculation of turbulent shear stress in
supersonic boundary-layer flows
A75-23209

- SUNDARAM, T. R.**
Effect of drag-reducing polymer injection on the lift and drag of a two-dimensional hydrofoil
[AD-A000262] N75-17624
- SUTTON, L. R.**
Development of an analysis for the determination of coupled helicopter rotor/control system dynamic response. Part 1: Analysis and applications
[NASA-CR-2452] N75-18178
- SWANSON, R. C., JR.**
Turbulent wake behind slender bodies including self-propelled configurations
[AD-A001040] N75-17319
- SWIFT, G.**
Static and wind tunnel model tests for the development of externally blown flap noise reduction techniques
[NASA-CR-134675] N75-18177
- SEALAI, K. J.**
Flight test experience with the F-8 digital fly-by-wire system
N75-18251

T

- TAKAHARA, K.**
Preliminary experiments on film cooling of turbine blades with injection near the leading edge. 1: Injection through holes located near the leading edge
[NAL-TR-371] N75-17359
- TALMADGE, R. D.**
Near field noise prediction for a linear array of turbojet engines
[AD-A001329] N75-18976
- TAM, C. K. W.**
Trailing edge noise
[AIAA PAPER 75-489] A75-25759
- TENA LOPEZ, P.**
The use of digital computers in air traffic control
A75-25862
- TERYAEV, E. D.**
The future application of aircraft-borne digital computers in complex-automated adaptive control systems for flight vehicles
[AD-A000193] N75-18253
- THOMAS, P.**
An experimental investigation of the core engine noise of a turbofan engine
[AIAA PAPER 75-526] A75-25790
- THOMPSON, T. L.**
Factors in the design of solid oxygen systems for aircraft
A75-25061
- THOMPSON, W. C.**
Landing impact studies of a 0.3-scale model air cushion landing system for a Navy fighter airplane
[NASA-TN-D-7875] N75-17342
- TIKHOMIROV, I. P.**
Handbook for aircraft mechanics /3rd revised and enlarged edition/
A75-23366
- TOPPING, R. P.**
Altitude evaluation of a variable cycle turbofan engine
[SAE PAPER 740806] A75-22938
- TRAYBAR, J. J.**
The effect of ground proximity on the lateral/directional aerodynamic and control characteristics of a tilt-wing V/STOL aircraft at high lift coefficients
[AD-A001584] N75-18227
- TREDICI, T. J.**
Proposed windshield for B-1 aircraft: An optical evaluation
[AD-A001078] N75-17350
- TROUT, A. M.**
Idle efficiency and pollution results for two-row swirl-can combustors having 72 modules
[NASA-TM-X-3208] N75-18240
- TUCK, D. A.**
Technology for improved safety
[AIAA PAPER 75-291] A75-25008
- TUNAKOV, A. P.**
Averaging of nonuniform flow in turbomachine flow traverses
A75-23821

- TYMCISZYK, J. J.**
Recent wake turbulence flight test programs
A75-24805
- Flight test investigation of the vortex wake characteristics behind a Boeing 727 during two-segment and normal ILS approaches (A joint NASA/FAA report)
[NASA-TM-X-62398] N75-17340

U

- UKOLOV, I. S.**
Adaption processes in aircraft guidance systems
[AD-A000354] N75-17329
- ULUSOY, A. G.**
Decision-making model for ATC system improvement
A75-24754
- UNAKOSHI, R.**
On stress in service condition and estimated fatigue life of blades in axial flow compressor
A75-23152
- URBAN, C. H.**
Evaluation of a high-capacity, firefighting foam-dispensing system
[AD-A006264] N75-18259

V

- VAGLIO-LAURIN, R.**
Studies of separated flows
[AD-A000348] N75-17626
- VAKHITOV, H. B.**
Substantiation of discrete-continuum low-aspect-ratio wing structural analysis scheme
A75-23798
- VALENZUELA CERVERA, L.**
Process of selection and quantization in the case of the fleet of Iberia
A75-25863
- VANCE, J. H.**
Design analysis of helicopter automatic and semiautomatic airborne precision pointing and tracking systems
[AD-A000834] N75-18229
- VANDERPLAATS, G. M.**
Application of numerical optimization to the design of low speed airfoils
[NASA-TM-X-3213] N75-18181
- VANOVERBEEK, J.**
Skin friction reduction in supersonic flow by injection through slots, porous sections and combinations of the two
[NASA-CR-2491] N75-17614
- VAUCHERET, Y.**
Wall corrections in transonic square test sections with perforated walls. Influence of the model span on lift corrections
[AD-A000138] N75-18266
- VAUGHAN, J. C.**
A new concept for airship mooring and ground handling
A75-25997
- VAUGHN, D.**
Analysis and preliminary design of an advanced technology transport flight control system
[NASA-CR-2490] N75-17295
- VENKATACHALAN, T. K.**
Potential contribution of high strength, high modulus aramid fibers to the commercial feasibility of lighter than air craft
A75-25992
- VITTEK, J. P., JR.**
Interagency Workshop on Lighter than Air Vehicles, Monterey, Calif., September 9-13, 1974, Proceedings
A75-25969
- VON GLAHN, U.**
Forward velocity effects on under-the-wing externally blown flap noise
[AIAA PAPER 75-476] A75-25750
- VON SALZEN, H.-H.**
A controller of variable structure for the reduction of the complexity of flight control systems
[DGLR PAPER 74-79] A75-24136

W

WALDMAN, G. D.
Influence of velocity, impingement angle, heating,
and aerodynamic shock layers on erosion of
materials at velocities of 5500 ft per s /1700 m
per s/
A75-25188

WALKER, C. D.
Operational considerations for the airship in
short-haul transportation
A75-25993

WALKER, H., JR.
Mooring and ground handling rigid airships
A75-25996

WASSERBAUER, J. F.
Design of a very-low-bleed Mach 2.5
mixed-compression inlet with 45 percent internal
contraction
[NASA-TN-X-3135]
N75-17363

WASSERMAN, R.
Report on program to improve MIL-F-83300
[AD-A001598]
N75-18226

WASSON, H. P.
Methods for predicting the aerodynamic and
stability and control characteristics of STOL
aircraft. Volume 2: STOL aerodynamic methods
computer program
[AD-A001581]
N75-17376

WATERS, W. J.
NASA vane alloy boasts high-temperature strength
A75-24003

WATKINS, T. C.
Stabilization of externally slung helicopter loads
[AD-A000893]
N75-18224

WATSON, V. R.
Measurements of supersonic jet aircraft wakes in
the stratosphere
A75-23962

WEBB, E. G., JR.
Pilot control/display factors for helicopters
/PIFAX-H/
A75-25070

WEBER, R. J.
The NASA research program on propulsion for
supersonic cruise aircraft
[NASA-TN-X-71666]
N75-18238

WEINHOLD, R.
Methods of inspecting and preventing work defects
during maintenance
A75-23049

WEISS, E.
An experimental investigation of the core engine
noise of a turbofan engine
[AIAA PAPER 75-526]
A75-25790

WELTE, D.
The significance of aerodynamic jet interference
in development and testing of the Do 31 V/STOL
transport
[NASA-TT-F-16165]
N75-17335

WESLER, J. E.
Airport noise abatement - How effective can it be
A75-23125

WESSEL, P. R.
Special problems and capabilities of high altitude
lighter than air vehicles
A75-26021

WESTLEY, R.
The near field sound pressures of a choked jet
when oscillating in the spinning mode
[AIAA PAPER 75-479]
A75-25752

WHITAKER, H. P.
System design of a rudder coordination system
[NASA-CR-142245]
N75-18223

WHITE, K. C.
Measurements and analysis of aircraft airframe noise
[AIAA PAPER 75-510]
A75-25776

WHITE, R. P., JR.
V/STOL rotor and propeller noise - Its prediction
and analysis of its aural characteristics
[AIAA PAPER 75-452]
A75-25734

WHITESIDES, J. L.
Influence of grazing flow on duct wall normal
impedances
[AIAA PAPER 75-494]
A75-25763

WHITHAM, G. B.
Mechanization of and experience with a triplex
fly-by-wire backup control system
N75-18248

WIDMALL, S. E.
The structure and dynamics of vortex filaments
A75-24481

WIENER, W.
Design of a guided flight vehicle according to
viewpoints of probability theory, taking into
account perturbation and control parameters
[DGLR PAPER 74-80]
A75-24137

WILBY, J. F.
Acoustic transmission through a fuselage sidewall
[NASA-CR-132602]
N75-18971

WILLIS, C. M.
Fluctuating pressures on aircraft wing and flap
surfaces associated with powered-lift systems
[AIAA PAPER 75-472]
A75-25747

WINBLADE, R. L.
NASA general aviation technology programs
[AIAA PAPER 75-290]
A75-25007

WITHEROW, R. G.
Technology update - Tethered aerostat structural
design and material developments
A75-26024

WITTLIN, G.
Experimentally verified analytical techniques for
predicting vehicle crash response
[AIAA PAPER 75-273]
A75-25006

WOOD, J. E. R.
Market assessment in connection with lighter than
air
A75-25980

The aerospace developments concept
A75-26000

WOOD, W. D.
Status of the wake vortex avoidance system
A75-26060

WOODGATE, L.
Comparison between dynamic stability boundaries
for NPL 9615 and NACA 0012 aerofoils pitching
about the quarter-chord
[ARC-CP-1279]
N75-17302

WOODROW, R. J.
The effects of forward speed on a number of
turbojet exhaust silencers
[AIAA PAPER 75-506]
A75-25772

WOODWARD, C. C.
Fluidic ejection seat control system
A75-25052

WOODWARD, D. E.
An aerodynamic load criterion for airships
A75-25985

WOOLLEY, J. H.
The near field sound pressures of a choked jet
when oscillating in the spinning mode
[AIAA PAPER 75-479]
A75-25752

WUENENBERG, H.
Problems and implementation possibilities of a
direct side force control in the case of fighters
[DGLR PAPER 74-84]
A75-24140

Y

YAMAMOTO, S. S.
Characteristics of air bearings with small inlet
holes for a precision coordinate measuring device
A75-25715

YIP, L. P.
Wind tunnel investigation of the wake near the
trailing edge of a distributed
upper-surface-blown flap
[NASA-TN-X-72637]
N75-18176

YLIVISAKER, I. B.
Study of alternative beacon based surveillance and
data link systems, volume 2
[AD-772136]
N75-17325

YU, J. C.
Decision-making model for ATC system improvement
A75-24754

Trailing edge noise
[AIAA PAPER 75-489]
A75-25759

Acoustic wave propagation in a lined duct with
non-uniform admittance
[AIAA PAPER 75-515]
A75-25781

Z

ZAEPPFEL, K. P.

Instrumentation and control system for an F-15
stall/spin

[NASA-TN-X-72647]

N75-17353

ZAGROUDINOV, G. M.

Predicting instrumental reliability of automated
aircraft system monitoring based on critical
parameter

A75-23810

ZAKHAROV, I. I.

Aircraft switching devices: Fabrication technology
and installation

A75-23369

ZIMMER, H.

Development and wind tunnel investigation of three
supercritical airfoil profiles for transport
aircraft

[DGLR PAPER 74-100]

A75-24147

ZWIEBACK, E. L.

Aircraft flyover noise measurements
[AIAA PAPER 75-537]

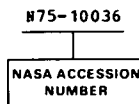
A75-25799

CONTRACT NUMBER INDEX

AERONAUTICAL ENGINEERING /A Special Bibliography (Suppl. 58)

JUNE 1975

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Listings in this index are arranged alphanumerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under that contract are arranged in ascending order with the IAA accession numbers appearing first. The accession number denotes the number by which the citation is identified in either the IAA or STAR section.

AF PROJ. 643A
 N75-17375
 N75-17376
 N75-17377
 N75-18226
 AF PROJ. 1368
 N75-17348
 AF PROJ. 1471
 N75-18976
 AF PROJ. 1987
 N75-17425
 AF PROJ. 3048
 N75-17531
 N75-18228
 AF PROJ. 6095
 N75-17332
 N75-17333
 AF PROJ. 7071
 N75-17346
 AF PROJ. 7755
 N75-17350
 AF PROJ. 8219
 N75-18227
 AF PROJ. 9783
 N75-17626
 AF-AFOSR-70-1885
 A75-25723
 AF-AFOSR-72-2365
 A75-25786
 AF-AFOSR-74-2611
 A75-25878
 AF-AFOSR-2316-72
 N75-17626
 ARPA ORDER 798
 N75-17345
 AT (11-1)-2249
 A75-23982
 AT (11-1)-3077
 N75-18167
 BMTF-LFF3-523-8891
 A75-24147
 BMVG-TR-720-R-7600-42-009
 A75-24140
 DA PROJ. 1F1-62207-AA-33
 N75-18224
 DAAG39-73-C-0237
 N75-17379
 DAAH01-73-C-0978
 N75-18229
 DAAJ02-71-C-0066
 A75-25006
 DAAJ02-72-C-0047
 N75-18224
 DAAJ02-73-C-0051
 A75-25006
 DAHC04-74-G-0097
 N75-18190
 DOT-FAA-ER-450-006
 N75-17653
 DOT-FAWA-2893
 A75-25016
 DOT-FA69WA-2129
 N75-17573
 DOT-FA70WA-2448
 N75-17325

DOT-PA71WA-2628
 N75-17334
 N75-17357
 DOT-PA72WA-2774
 N75-18263
 DOT-PA72WA-3023
 A75-25731
 A75-25803
 DOT-PA72WA-3053
 A75-25746
 DOT-PA72WAI-242
 A75-26037
 N75-17326
 DOT-PA73WA-3320
 N75-18194
 DOT-FR-30004
 N75-18192
 DOT-OS-00002
 A75-25751
 DOT-OS-30034
 A75-25792
 F-INK-81133-71-302 (21898)
 N75-17299
 FAA PROJ. 081-431-020
 N75-18259
 FAA PROJ. 214-531-070
 N75-18222
 F19628-71-C-0116
 A75-25926
 F19628-73-C-0002
 A75-26037
 N75-17326
 F33615-71-C-1206
 N75-18227
 F33615-71-C-1572
 A75-25185
 F33615-71-C-1722
 N75-18226
 N75-18254
 F33615-71-C-1861
 N75-17375
 N75-17376
 F33615-71-C-1901
 N75-18228
 F33615-71-C-186116
 N75-17377
 F33615-72-C-2083
 N75-17348
 F33615-73-C-1054
 N75-17332
 F33615-73-C-1146
 N75-17333
 F33615-73-C-4142
 N75-17346
 F44620-68-C-0018
 A75-22868
 F44620-69-C-0090
 A75-24481
 F44620-69-C-0091
 N75-17314
 NASW-2481
 N75-17335
 NAS1-10309
 N75-17361
 NAS1-10856
 N75-18178
 NAS1-11839
 N75-18971
 NAS1-12052
 N75-18185
 N75-18186
 NAS1-12437
 N75-17295
 NAS1-12505
 A75-25744
 NAS1-12553
 N75-17344

NAS1-12910
 NAS1-13142
 NAS1-13226
 NAS1-13229
 NAS1-13295
 NAS2-5462
 NAS2-7208
 NAS2-7684
 NAS3-15568
 NAS3-16831
 NAS3-17863
 NAS3-17865
 NAS4-1881
 NAS4-2068
 NAS7-100
 NGL-22-009-548
 NGR-05-002-239
 NGR-09-010-064
 NGR-09-010-085
 NGR-10-005-127
 NGR-22-009-727
 NGR-31-001-307
 NGR-33-016-167
 NGR-33-016-177
 NGR-33-016-201
 NGR-41-001-027
 NGR-47-004-160
 NGR-47-005-146
 NGR-47-005-181
 NGR-48-002-047
 NR PROJ. 062-325
 NR PROJ. 062-481
 NR PROJ. 212-224
 NR PROJ. 213-088
 NSF GK-30325
 NSG-1021
 NSG-2024
 NSG-3015
 NSG-7072
 N00014-67-A-0151-0029
 N00014-71-C-0063
 N00014-72-A-0136-0004
 N00014-72-C-0191
 N00014-74-C-0127
 N00019-70-C-0276
 N00019-71-C-0297
 N00019-73-C-0460
 N00421-72-C-6702
 SWEDBTD-73-4381
 SWEDBTD-73-4722
 ZR00001

126-61-14-05-00
 N75-17361
 500-06-23-01
 501-04-01-02
 501-06-05-07
 501-23-11-05
 501-24
 501-26-01
 501-26-06
 505-01-41-06
 505-03
 505-03-12-05
 505-04
 505-08-31-01
 505-10-12
 505-10-41-03
 506-26-30-02
 760-17-01-11
 760-66-01-02-00
 N75-18182
 N75-18030
 N75-18179
 N75-17368
 N75-18239
 N75-18244
 N75-18245
 N75-17294
 N75-18240
 N75-17360
 N75-18231
 N75-18232
 N75-18233
 N75-18234
 N75-18235
 N75-18236
 N75-17363
 N75-17342
 N75-18184
 N75-18181
 N75-18176
 N75-18187
 N75-18180
 N75-17344

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